FOOD TECHNOLOGY

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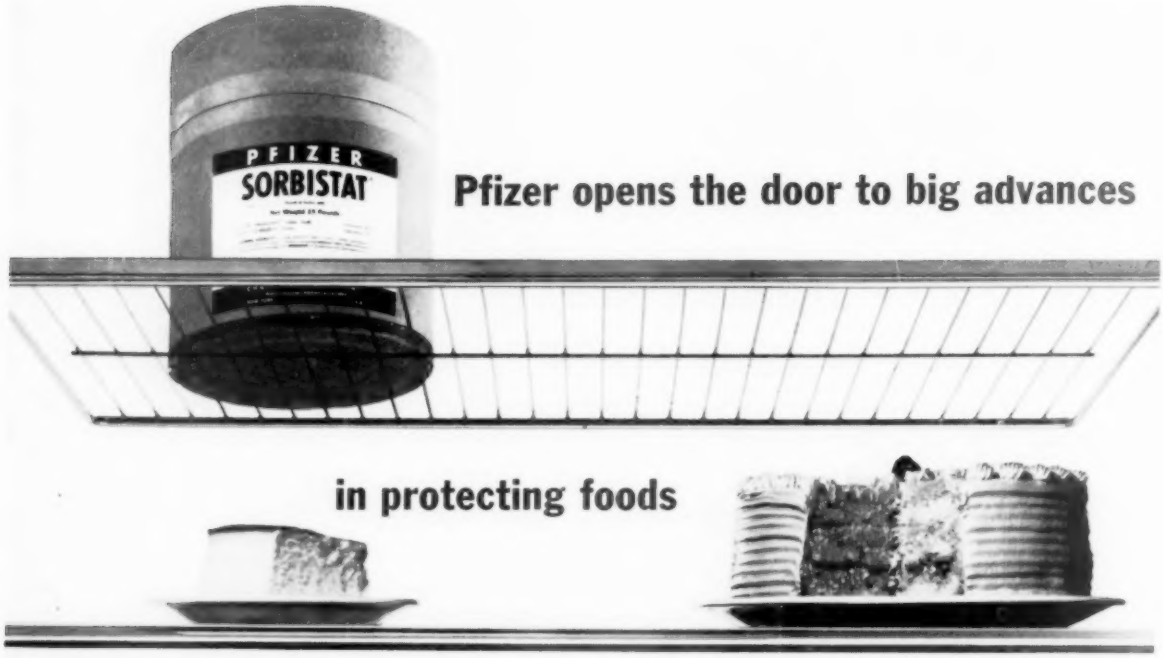
It's Pittsburgh in '57
Seventeenth Annual Meeting of IFT
May 12-17, 1957

Pages 293-336

July, 1956 Volume 10, Number 7



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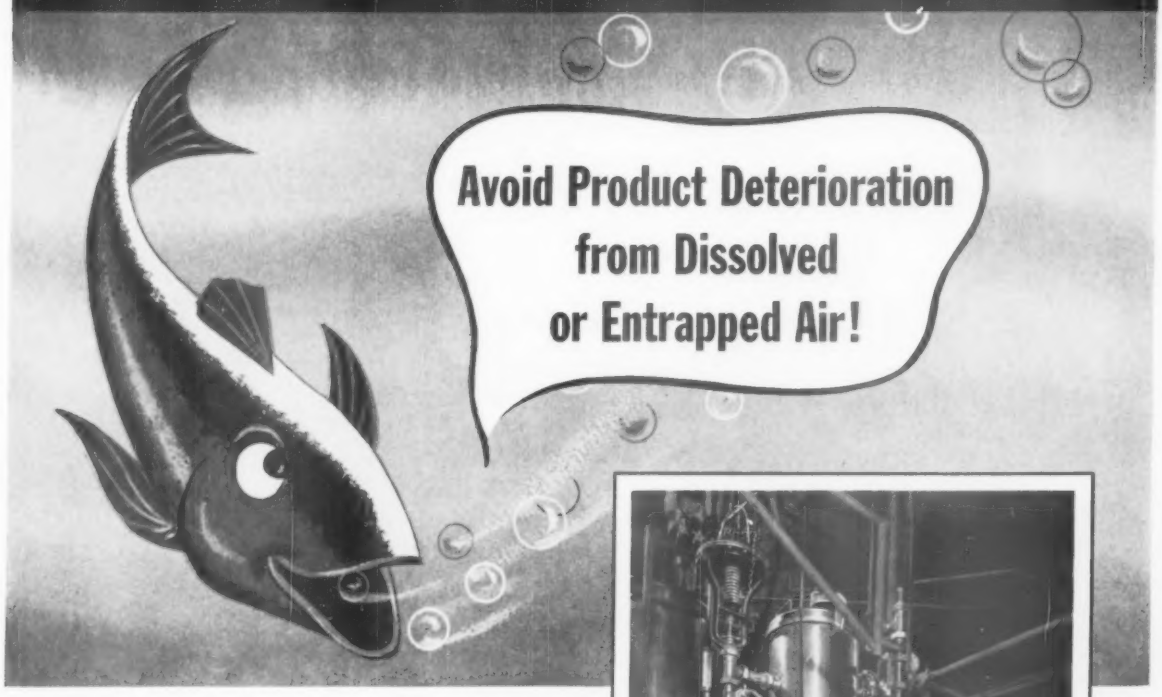

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→ POULTRY!

IFT ACTIONS AND REACTIONS...

NEW IFT PRESIDENT, GEORGE GARNATZ, BEGINS TERM

George Garnatz, newly inaugurated president of the Institute of Food Technologists, was trained as a chemical engineer and has spent his entire career in research and development as it relates to food. He is a charter member of the Institute.

In succeeding to the office of President of the Institute of Food Technologists, Mr. Garnatz stated, "I am keenly aware of the honor that the presidency of this organization represents as well as the responsibility it imposes on me. But it is with an attitude of great optimism and expectancy that I assume the responsibilities of office, hopeful of cooperation from every quarter. It is my wish to contribute, in continuity with its past great record, to the forward advance of the Institute and to enhance, wherever I can, the appreciation of the contributions to society made by the Food Technologist. I shall administer the affairs of the Institute to the best of my ability and to the end that another successful year may be experienced, culminating in another fine meeting in Pittsburgh, May 12 to 17, 1957."

A busy life. George Garnatz, director of the Kroger Food Foundation in Cincinnati, Ohio, was born in Cincinnati. While still a student at the University of Cincinnati, his research in the food field attracted the attention of officials of the Kroger Company, and shortly after his graduation in 1921 as a chemical engineer, he was employed by the firm to establish a baking laboratory. When the Food Foundation was opened, the laboratory was consolidated with it. Mr. Garnatz became director of the Foundation in August, 1945. It has become a nationally known, productive food research and development laboratory since that time.

At the university, Mr. Garnatz was elected to Tau Beta Pi, honorary engineering fraternity, and to Alpha Chi Sigma, professional chemical fraternity. His other memberships include the American Association of Cereal Chemists, of which he was president in 1939, American Chemical Society, American Society of Bakery Engineers, Institute of Food Technologists (charter member), American Oil Chemists Society, American Association for the Advancement of Science, the Society of the Chemical Industry and the Engineering Society of Cincinnati. He also is a fellow of the American Institute of Chemists and the New York Academy of Sciences, as well as a member of the honorary research society of Sigma Xi. He is a member of the Advisory Council on Food Engineering to the Illinois Institute of Technology and also serves as chairman of the Baking Industry Research Advisory Council and vice-chairman of the Grain Research and Marketing Advisory Committee, U.S.D.A., in connection with federally supported research work. He is listed in *Chemical Who's Who* and *American Men of Science*.

IFT President, George Garnatz

Mr. Garnatz in 1953 was selected "Engineer of the Year" by the Technical and Scientific Societies Council of Cincinnati, from among the 5,500 members of the 24 societies that make up the Council.

The new president of IFT has long been active in technical affairs. He has been chairman of the Committee on Flour Specifications and Methods for Testing Flour of the American Association of Cereal Chemists and a member of the sub-committee on Cereal and Baked Products of the National Research Council's Committee on Foods.

Patents held by Mr. Garnatz include a device for cooking shrimp and one for the continuous preparation of cake batter in which ingredients enter one end of the machine and come out the other as prepared batter.

U. S. INTERDEPARTMENTAL COMMITTEE ON NUTRITION FOR NATIONAL DEFENSE ACCEPTS PRESIDENT RHEE'S INVITATION TO ASSIST IN KOREAN NUTRITION SURVEY

Health aid rather than dollar aid will result from a nutritional survey of broad scope to be conducted in Korea, starting in June. First objective will be to assess the nutritional status of Korea's military forces. An extremely mountainous type of territory and cold in winter, Korea presents something of a problem in regard to troop feeding on account of a high calorie requirement due to active life of the soldier, the climate, and terrain. President Syngman Rhee, through Korean Ambassador Yang, has requested U. S. cooperation in extending the nutritional survey made in Korea in 1953 under the auspices of the Far East Command, U. S. Armed Forces, during the Korean action. Korean personnel will serve alongside the U. S. team in the conduct of the survey. U. S. specialists composing the team are Dr. R. R. Williams, leader; Dr. Gerald F. Combs, nutritionist, University of Maryland; Dr. William J. McGanity, physician, Vanderbilt University School of Medicine, and Dr. Z. I. Kertesz, food scientist, Cornell University and New York State Agricultural Experiment Station, Geneva.

The survey will develop information on the nutritional status of the Korean military forces, assist the Korean Government in developing a nutrition service, and offer recommendations whereby adequate nutritional standards for all the people in Korea may be established and maintained. The nutritional requirements and dietary standards necessary for optimum health of the Korean troops will be derived from extensive dietary studies. Specific projects are: the type and quantity of food consumed; distribution methods;

(Continued on page 6)

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(Continued from page 4)

availability of foods; and processing practices. Practical means of improving foods and food production will be suggested wherever indicated.

Dr. Z. I. Kertesz—to represent food science and technology aspects of Korean Nutritional Survey.

Dr. Kertesz, IFT Councillor and consulting editor of the IFT journals, was selected for a technical assistance mission to Ceylon two years ago. His assignment was to study food resources and production and to recommend means of improving Ceylon technology. He brings to the Korean survey task not only a specialized knowledge of food problems but a broad background of information and experience in the feeding and food technology problems of Eastern peoples.

INTERNATIONAL INSTITUTE OF REFRIGERATION

Commission IV—Commission IV of the International Institute of Refrigeration met at Sidney Sussex College, Cambridge, from 6–10 April 1956. On 11 April the Commission convened at the Experimental Kitchens of the Scientific Adviser's Division, Ministry of Agriculture, Fisheries and Food, in London.

Attendance at the meetings included representatives from Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland, United Kingdom, U.S.S.R., together with observers from the Fisheries and Nutrition Divisions of FAO.

Commission IV deals with "the application of refrigeration to foodstuffs and agricultural products." The President of the Commission is Dr. J. C. Fidler of the Ditton Laboratory, Larksfield, Kent, England, who presided at the meetings.

On 6 and 7 April the subject of discussion was "Eggs" and papers were presented on spoilage, germicidal dips, pasteurisation, storage, protein denaturation and methods of quality assessment. On 9 and 10 April the subject was "Quality" with emphasis on methods of assessment and problems of correlating objective and subjective results.

The program was as follows:

EGGS

C. L. Heller—Introduction: bacteriology of hens' eggs.

J. Brooks—The detection of cleaned eggs.

N. R. Knowles—Keeping quality performance of "shell pasteurised" and oiled eggs during cold storage.

G. Borgström—Pasteurisation of dirty shell eggs in oil after washing.

G. Borgström—Investigation into the stabilisation of

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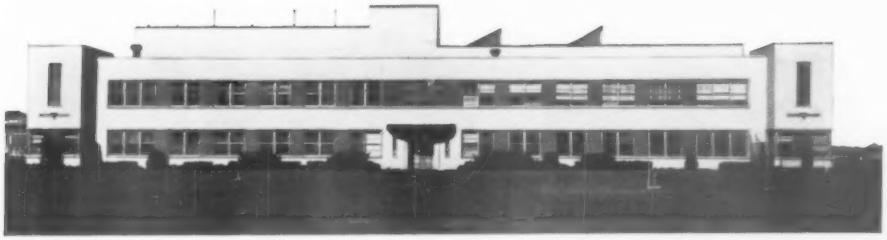
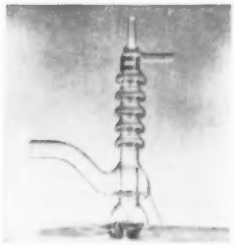


This is the house that vacuum built

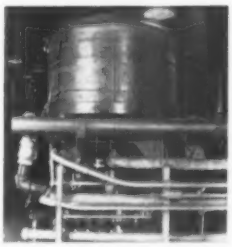
This is the pump that made the vacuum

We developed this type of high vacuum pump back in the 1920's while looking for a way to improve the packaging of film for the tropics. It happens we never used it for that because a better tropical packaging technique turned up.



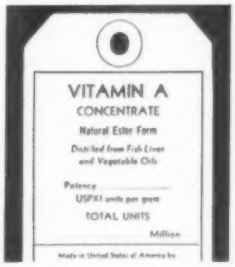
This is the molecular still that used the pump

The new pump was too good to forget. Somebody got the idea of using it on a high vacuum molecular still. It worked fine. So we started distilling all sorts of heat-sensitive materials that you couldn't distill any other way.



This is the vitamin A that was made in the still

When we got the idea of distilling fish liver oils to concentrate the vitamin A we started something. There was no concentrated vitamin A of such high quality available at the time. This was something really new.



This is the margarine with no fishy taste

Molecular distillation not only produced a highly concentrated product, it removed most of the fishy smell and taste. This was a big boon to the margarine industry when, in the 1930's, it first started fortifying the product.

This is the kettle that emptied the stills

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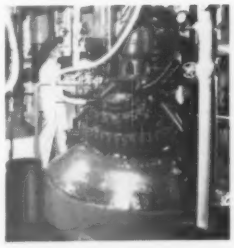

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(Continued from page 6)

shell egg quality by combining various preservation treatments.

H. R. Hinton—Pasteurisation of eggs in shell.

R. F. Gordon, E. G. Harry, and J. F. Tucker—The use of germicides in the washing of dirty eggs.

C. Antoniani, G. Botalla, and A. Monzini—Etude de l'action du froid sur les macromolecules protidiques: Observations sur l'ovo-albumine.

M. D. Astudillo, A. Sanz, and F. Sanz—Denaturation by heat and by cold of the ovomucin and ovomucoid.

R. Baetsle—Storage of eggs.

J. Kuprianoff—The distinction between fresh and cold stored eggs.

Ir. Konings and J. Tukker—Marketing of eggs by poultry farmers and the various trade channels between producer and consumer in the Netherlands.

D. G. Rutov—Some notes on storage of eggs in Russia.

M. Anquez—Le marché des œufs en France.

G. Borgström—Marketing of eggs in Sweden.

QUALITY

E. C. Bate-Smith—Introduction.

J. M. Harries—Quality Assessment.

D. Sheppard — Subjective methods of assessment of quality.

J. M. Shewan and J. Liston—The objective and subjective assessments of quality of fish.

G. Borgström—Preliminary communication regarding a procedure of pretesting testers (judges) for organoleptic evaluation.

P. Chaponneaux—Qualité de la sardine: Appreciation de la "tenue" par la mesure directe de la résistance des flancs.

J. Orshan—A proposed method for the quality control of imported and exported frozen fish.

M. Hauefort—Rémarques sur les méthods subjectives et objectives de détermination de la qualité des oeufs en coquille.

J. Brooks and H. P. Hale—Fluorescence measurement and egg quality.

J. Moreno Calvo—Paper chromatography as an analytical tool in the field of cold storage of foods.

E. H. Callow—The quality of fat in beef animals.

D. Basille—Rémarques sur les méthodes subjectives et objectives de détermination de la qualité du lait et celle des oeufs cassés congelés.

W. F. Hampton
Fish Processing Section,
Fisheries Division
Food and Agriculture Organization,
United Nations.

IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

SOME PROBLEMS OF PROTEIN CHEMISTRY IN FOOD PRODUCTS*

Robert Jenness
Department of Agricultural Biochemistry, University of Minnesota, St. Paul, Minnesota

Proteins are extremely important constituents of human foods because of the essential amino acids that they supply. To meet the requirements for these amino acids a daily intake of 70 g. of protein is recommended. The proteins in the average dietary are drawn from a number of natural sources. In the United States about 30% of the food protein is contributed by cereal foods, 30% by meat, fish and poultry, 30% by dairy products, 7% by fruits and vegetables, and the remainder by miscellaneous sources. In these food products, of course, proteins occur in various forms and mixed with various other materials such as carbohydrates, fats and mineral constituents.

Proteins are rather labile materials; they are susceptible to alteration by some of the modern techniques of food processing and storage. Such techniques have been developed to conserve the nutrients in natural food sources for consumption at a time or in a place other than that of production or in a more palatable or convenient form. Some of them produce changes in proteins. These changes may be grouped into three categories—nutritive value, flavor, and physical structure and stability. It is important to recognize that a treatment that improves one property may impair another and thus that the effects of processing treatments on food proteins must be considered from the standpoint of the overall utility of the resulting product.

Professor Robert Jenness . . . speaker at the March meeting of the Southern California Section.

Present emphasis. At present there is a great deal of emphasis in the field of protein chemistry on isolating and characterizing the individual proteins in various natural systems. This emphasis is based on the thesis that it is necessary to know the fundamental

(Continued on page 10)

* Condensed version of a paper presented before the Southern California Section of the Institute of Food Technologists, March 21, 1956.

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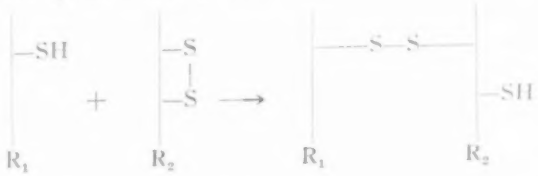
(Continued from page 8)

chemistry of the individual components or building blocks of a system in order to understand the reactions which occur under the influence of various treatments. This line of attack is being applied in the field of the food proteins with assiduous work on the isolation and characterization of the individual proteins from such systems as eggs, soy beans, wheat, meat and milk. Throughout protein chemistry the criteria of protein homogeneity have become more critical and rigorous as new techniques have become available. Proteins formerly considered to be individual entities are now recognized in many cases to be mixtures; this subdivision of the older groups has led to confusion in nomenclature in some cases. In all of the work on isolating and characterizing individual protein components, it is very important to avoid artifacts and one must always bear in mind that reactions in the original system often involve non-protein reactants as well as proteins themselves.

Protein chemists are interested in characterizing the proteins in terms of their particle sizes, their amino acid composition and sequence, their electrical charges, and their spatial arrangement. Briefly, the present position on protein structure is that the primary structure consists of polypeptide chains of amino acids. The only covalent bonds in such structures are those of the peptide bonds joining the amino acid residues and the disulfide linkages of the amino acid cystine. The disulfide linkages play a very important role in protein structure since they can form "bridges" holding the individual polypeptide chains together. Two general kinds of protein structure are recognized—the fibrous consisting of aggregates of polypeptide chains not folded or coiled and the globular consisting of structures that are coiled and folded in a very particular way. The former structure is characteristic of proteins of structural importance, the latter of those having specific metabolic functions. Globular proteins exhibit a high degree of specificity. They occur in discrete sizes with a strong tendency for a given protein to consist of particles of a single size.

Protein denaturation. In discussing the effects of processing treatments on proteins in terms of nutritive value, flavor and physical stability, it is convenient to speak in terms of the concept of protein denaturation. It has long been recognized that a number of treatments such as heat, ionizing radiation, foaming, detergents and various organic solvents cause profound changes in the properties of proteins, particularly globular proteins. These agents do not seem to produce any splitting of the covalent bonds in the proteins but rather appear to produce an unfolding and uncoiling of the specific structure of the protein. This process is spoken of as denaturation. Its manifestations include insolublization and the exposure of various reactive groups. These effects can be illustrated admirably by the effect of heat on milk—the system with which the author is most familiar. Milk contains a number of proteins which roughly may be grouped in two classes; the caseins which occur as complex particles combined with calcium and phosphate and the whey proteins. The casein particles are subject to destabilization by drastic heat treatments but evidently this process involves something other than denaturation since the protein itself does not seem to be altered in the process. The whey proteins, on the other hand, are susceptible to denaturation by heat with the result that they are rendered less soluble. This insolublization causes difficulty in the manufacture of a product like cottage cheese because the denatured whey proteins interfere with the preparation of the proper type of curd from the casein. Some of the proteins of whey carry concealed or inactive sulfhydryl groups of the amino acid cysteine which are liberated by heat treatment. When the molecule is uncoiled and unfolded, as a result of heat denaturation, these groups are exposed and become very much more reactive. Their exposure bears an important relation to flavor since they are important contributors to the cooked flavor in heated milk. Furthermore, since they are readily oxidized, they may serve as antioxidants protecting the fat in the product against oxidation. The exposure of sulfhydryl groups also opens up the possibility of aggregation which can proceed by the following mechanism:



This picture of the changes occurring in the proteins of milk as a result of heat treatment has only been demonstrated by a study of isolated individual proteins. Similar phenomena apparently occur in other protein-bearing food products.

The denaturation of proteins bears an important relation to their nutritive value because the unfolding and uncoiling of the molecules make them more available to attack by enzymes and thus may improve their digestibility. Furthermore, various toxic and inhibitory factors, some of which are protein in nature, may be inactivated by denaturing treatments such as heat. Outstanding examples of such factors are trypsin inhibitors occurring in various foods such as soybean products and avidin occurring in egg white which combines with biotin rendering the latter unavailable.

The sugar-protein interaction. Another very important phenomenon occurring upon processing and storage of protein containing foods is the sugar-protein interaction occurring between reducing sugars and compounds including proteins which carry free amino groups. The first step in this interaction appears to be a simple condensation of the amino group with the carbonyl group of the sugar. This is followed by an extensive series of reactions and rearrangements which result in insolubilization of the protein, the development of brown color, the development of fluorescent materials, and undesirable odors and flavors. The brown-

(Continued on page 14)

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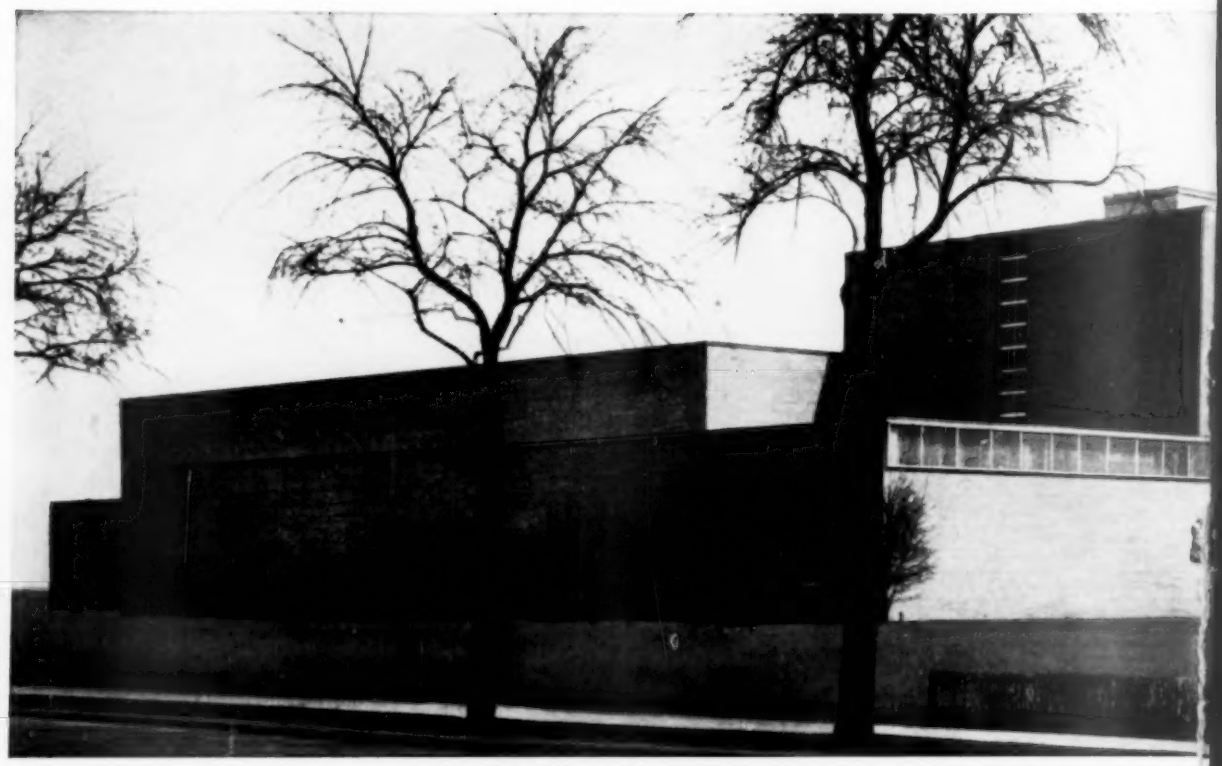

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(Continued from page 10)

ing reaction impairs the nutritive value of the product because it ties up the amino acid lysine which carries many of the free amino groups in the protein and renders this essential amino acid unavailable for use by the consumer. The rate of this reaction depends very much upon the concentration of reactants and upon the water content. The rate increases with increase in concentration up to a certain point beyond which the water content becomes critical and the rate decreases with continued increase in concentration. It is often desirable to choose conditions that minimize the browning reaction. In the case of milk products, the use of high temperature, short-time heat treatments offers considerable promise in this direction. A great deal of work has been done on the proteins of foods, but a great deal more will be necessary to elucidate the problems in which they are involved.

MOHAWK VALLEY . . . .

On May 8, 1956, members of this section were guests of the Sterling Winthrop Research Institute at Rensselaer, New York. Members met at the Institute at 6:00 p.m. for a social hour and dinner.

Following dinner Mr. D. J. Hanor, Director of Personnel and Public Relations of the Sterling Winthrop Institute, spoke on the history and growth of the Company. Mr. Hanor had been with Sterling Winthrop since its early days and was able to give many interesting sidelights on its history.

After the talk, the members of the Section were taken on a tour of the Institute. Each tour group was accompanied by a guide who explained the function of the laboratories, pilot plant and numerous other excellent facilities.

OREGON . . . .

The Section held its annual meeting in Portland, Oregon, April 20, 1956, at the plant of the American Can Company, 2127 Northwest 26th Street. The meeting began at 2:30 p.m. with a tour of the plant in which the different operations of manufacturing metal cans and paper milk cartons were observed. After the tour, an informal question-and-answer period was held in which the different manufacturing operations were discussed. It was an interesting tour and the work done by the American Can Company in making the arrangements was appreciated by the section membership.

The election of new officers was held with the following results:

Chairman: Mr. Alton C. McCully, Research Director, Eugene Fruit Growers Association, Eugene, Oregon.

Vice-Chairman: Mr. Alvin H. Randall, General Manager, United Growers and Producers Coop., Salem, Oregon.

Secretary-Treasurer: Dr. Oliver J. Worthington, Associate Professor, Food Technology Department, Oregon State College, Corvallis, Oregon.

Executive Committee: Mr. Richard T. Nielsen, Northwest Packing Company, 554 North Columbia Blvd., Portland, Oregon; Mr. J. T. Yolland, Continental Can Company, 1208 Yeon Building, Portland 4, Oregon.

It was announced at the meeting that $100.00 had been donated to the Ernest H. Weigand Award by the North Pacific Canners and Packers, Inc., 5200 S. E. McLoughlin Blvd., Portland 2, Oregon. This money will be given to an outstanding senior in Food Technology at Oregon State College next year. The Ernest H. Wiegand Award is sponsored jointly by the Oregon Section and the Food Technology Club of Corvallis. The members expressed their sincere appreciation to the North Pacific Canners and Packers for the generosity of this organization. The meeting adjourned and reconvened at the Henry Thiele's Restaurant, Portland.

The guest of honor and speaker of the dinner meeting was President LaVerne E. Clifcorn. He expressed his pleasure in being in the Pacific Northwest and meeting with the Oregon Section. Dr. Clifcorn told the group that he was trying to instill pride in members in belonging to the profession of Food Technology; that it is one of the great professions and represents the largest industry in the United States. He also discussed the subject of chemical additives in foods from both the legislative and Food Technologists' aspect and emphasized the enormous problems encountered in defining chemical additives. Dr. Clifcorn was interesting, stimulating, and warmly received by the members.

NEW YORK . . . .

Antioxidants Play Vital Role in Protecting Our Food Supply. How antioxidants, in combination with synergists and metal scavengers, combat deterioration in processed foods was the subject of two informative talks at the April 18 meeting of the New York Section of the Institute of Food Technologists.

Speakers were Mr. G. F. Siemers, Technical Director, Vitamin Division, Hoffmann-La Roche Inc., Nutley, N. J., and Dr. B. N. Stuckey, Research Division, Eastman Chemical Products, Inc., Kingsport, Tenn.

In discussing water-soluble antioxidants, Mr. Siemers cited the role of ascorbic acid as a color-retention factor in frozen fruits, meats, vegetables and juices. Although sulfur compounds are also effective, he called their applications limited, since they can destroy food values.

Ascorbic acid inactivates dissolved oxygen in milk and milk products to prevent rancidity. However, required levels are high and its use is not universally permitted in this country. Curbing oxidized flavor in beer, and preventing off-flavors in irradiated foods, are other applications for ascorbic acid.

In his talk on fat-soluble antioxidants, Dr. Stuckey described the use of various food-approved combinations of phenolics in extending the shelf-life of fats, oils, cereal products, essential oils, nuts and confections. Types of rancidity occurring in fats and oils were de-

(Continued on page 16)

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(Continued from page 14)

tailed, along with mechanisms of oxidation and antioxidant action.

Of special interest were graphs of test data showing relative effectiveness of basic antioxidants and antioxidant mixtures in stabilizing lard and corn oil, also pastry, crackers, and potato chips made with these products. Tests were conducted by the Active Oxygen Method and the Schaal Oven Method.

Results indicated that the best all-around antioxidant generally is a combination of basic antioxidants and a synergist or metal scavenger to inactivate trace metals.

Dr. Stuckey emphasized that most of the complaints from the use of antioxidants in fats and oils are due to inadequate mixing of the antioxidant into the fat. Much of the discoloration usually attributed to propyl gallate can be corrected by proper blending.

Under certain conditions, however, water coming in contact with the fat will leach propyl gallate and cause discoloration due to iron contamination. Therefore, every effort should be made to get complete dispersion of the antioxidant into the fat.

GREAT LAKES . . .

Plant Trip. Forty members met at ten o'clock in the morning, April 20, at Windsor, Ontario, to take a trip through the plant of Hiram Walker & Sons. The members saw the grain grinding operation, the cookers, fermenters, distillation and the reclaiming equipment and methods used by this up-to-date distillery. At the conclusion of the tour, Mr. Bain, their chief chemist, welcomed the group to the plant, explained some of the operations and answered questions from the members.

Technical Session. Due to a large attendance at the meeting, it was found necessary to hold the Technical Session at Assumption College in Windsor. The four speakers from the Department of Agriculture did an excellent job in presenting the work of their particular Departments.

Dr. A. H. Jones, Food Microbiologist of the Department of Agriculture, Ottawa spoke briefly on methods of processing; pickling and brining with a reference to some of the work which his Department has done along this line; concentration of Tomato Paste; the tests made on fungicidal paints and in closing referred to the work which his Department is doing on thermoacidurans.

Dr. W. D. Powrie, Senior Food Technologist, from the Horticulture Division of the Department spoke on "A Food Technologist Looks At Canadian Canning Problems." In opening his remarks, Dr. Powrie spoke on developments of new products and work done to improve old products. He spoke particularly about the need for consistent high quality and particularly the work which has been done by his Department to improve the quality of Apple Juice. Some of the investigation on the effect of storage of ripe apples was covered in detail. In summing up the operation of his Department, he expressed the aim that they hoped to improve the quality of Canadian canned products, working closely with industry.

Dr. H. L. Gray, Head of Stored Products Insect Unit, Department of Agriculture, Ottawa, spoke on "How To Improve Sanitation in Flour Mills, Grain Storages and Various Food Manufacturing Establishments." In his opening remarks, Dr. Gray pointed out that the loss from insect infestation amounts to some $500,000,000.00 annually in the United States. He spoke about the resistance which certain insects develop toward new sprays. In discussing the problem of keeping infestation at a minimum, Dr. Gray emphasized that what was needed was a good man who is patient, thorough and persistent. This man working at frequent and regular intervals, could help to keep down insect infestation. In illustrating this point, Dr. Gray mentioned that to keep flour beetles in a mill at a static level, it was necessary to kill 99% of the adult population every month. The need for good housekeeping and good layout in building a plant was emphasized by the speaker.

Dr. A. G. O. Whiteside, Cerealist from the Cereal Crops Division Department of Agriculture, Ottawa, spoke on "What Our Experimental Milling and Baking Tests Have Revealed." Mr. Whiteside spoke about the breeding program at the Department of Agriculture and emphasized the care which must be taken in developing new varieties by telling about the development of the variety Selkirk. The speaker told about the production of the Selkirk seed in 1949, its re-selection in 1953 and its licensing in that same year. In 1955, 3 million acres of this wheat was grown in Western Canada. In the speaker's estimation, some 7 out of 20 million acres will be grown in the year 1956. The importance of high quality wheat was emphasized and the pieces of equipment which are used in the Division's Laboratories to check the quality of wheat were shown on slides.

Business Meeting: The Business Meeting of the Great Lakes Section, Institute of Food Technologists was called to order by the Chairman, Mr. George Alexander at 5:25 p.m. at Assumption College on April 20th.

After the reading of the minutes, the Treasurer's report was read and accepted on motion of W. F. Robertson and seconded by Karl Envoldsen.

The Chairman of the Membership Committee, Karl Envoldsen, made a short speech to the membership outlining the broad scope of the IFT and the importance of our meetings as a training ground for new technologists.

The Secretary then asked for any news items and the Chairman thanked the speakers of the afternoon for their splendid papers.

The meeting adjourned at 5:40 p.m.

Dinner Meeting: The dinner was held at the Prince Edward Hotel at 6:30 p.m. with 56 members in attendance. Several door prizes given by Canadian Food Processing Companies and the Dominion Glass Company of Canada were presented. The gift package given to each member attending was donated by Cana-

(Continued on page 18)

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(Continued from page 16)

dian Canners Limited, through the kindness of Doctor Larry White of that Company.

After the dinner, Dr. C. A. Morrell, Director of the Food and Drug Directorate of the Department of National Health and Welfare, Ottawa, spoke about the responsibilities of the Food and Drug Directorate for public health. The speaker discussed the differences between Canadian and American Food Laws and pointed out that in Canada the aim of the Food and Drug Directorate was to see that the public have safe, clean, wholesome food, well packaged and at a reasonable cost. Commenting on the old adage that what you don't see won't hurt you, Dr. Morrell stated the position of the Directorate—"We do not believe that sterilized filth is food."

Discussing additives to foods, Dr. Morrell pointed out that in the old days a chemical was added to cheat the customer but today additives are put in foods for a more specific reason, particularly to add shelf life to the product. In discussing the use of antibiotics in foods, the speaker asked the question as to whether it was wise to accept the temporary advantages of antibiotics in foods. "We should continually ask ourselves if the risk is worth while."

Acknowledgment: The Executive Committee of the Great Lakes Section wishes to thank Mr. C. Hamilton Kenney, Information Service, Canada Department of Agriculture, Ottawa, and an Associate Editor of FOOD TECHNOLOGY, for his counsel in planning the speakers' program for the "Canada Day" meeting.

FLORIDA . . . .

Year's Activity of Florida Section in Review. The first meeting of the Section was held on October 15, 1955, at the Fontainebleau, Miami, at the close of the Canners' Convention (Florida). Mr. C. D. Greenleaf, National Canners' Association, presented a paper prepared by Dr. Howard L. Stier, also of the National Canners' Association, entitled, "Usage of Statistical Quality Control in the Food Industry."

The next meeting was held on December 15, 1955, at Pearce's Restaurant, Orlando. Following dinner, Col. Paul Logan, director of research of the National Restaurant Association, discussed, "Development and Problems of the Public Feeding Industry."

On January 12, 1956, a Section meeting was held at the Auditorium of the Citrus Experiment Station, Lake Alfred. Mr. George O. Sampson, district supervisor of the American Can Company, with the aid of colored slides, presented the results of the atomic tests in which he took part, which was "unclassified material."

The Section held two regular meetings in February. The first was held on the 7th, at the Columbia Restaurant in Tampa. Following dinner, Mr. R. L. Lloyd, director of research of American Maize-Products Company, spoke on "Recent Research Developments in Sugar." The second meeting was held at the Park Restaurant, Winter Haven, on the 29th, when Dr. Hugh Mottern, manager of research labs of Kraft Foods Company, Chicago, spoke with the aid of moving pictures on the subject, "Cheese Making—Old and New."

On March 15, a meeting was held following dinner at the Park Restaurant in the Auditorium of the Citrus Experiment Station, Lake Alfred. Mr. K. C. Tucker, manager of Food Industries Division of Oakite Products, New York, spoke on "Sanitation Agents and Their Action." During this meeting, the Nominating Committee was named.

The next meeting was held on April 18 at Morrison's Cafeteria and Restaurant, Tampa. There was no planned speaker for this meeting. The meeting was set aside for the discussion of business of the Section.

The last meeting of the year was held on May 17 in the San Juan Hotel Ballroom, Orlando. Following dinner, the results of balloting for new officers was announced by the chairman of the Nominating Committee, Mr. Robert Olson. The officers for 1956-57, to take office on July 1, are as follows:

Chairman: Mr. W. Clifford Scott.

Vice Chairman: Mr. C. W. DuBois.

Secretary-Treasurer: Mr. Omar McDuff.

Councilor: Mr. Donald O'Brien.

Executive Committee: Mr. Wilbur Enns, Mr. James Bonnell, 2 years; Mr. Howard Trumm, Mr. W. G. Mitchell, 1 year remaining.

There were two speakers for the evening. Mr. John Fox, president of Minute Maid Corporation, spoke on "What Management Expects of Its Technical Staff." The second speaker was Mr. Willard H. Biedler, director of research of C. H. Musselmann Company, who discussed, "What a Technical Staff Can Do for Management." This was the largest meeting of the season.

This Section drew up during the year a new constitution, together with a new set of by-laws, which were formally adopted on February 29 and May 17, respectively. Two new committees have been formed. One is a committee entitled, "Citrus Products Research Committee." The other is the "Public Relations Committee."

DIXIE . . . .

The annual business meeting of the Dixie Section was held May 18th and the following officers were elected for the 1956-57 term:

Chairman: T. W. Kethley, Engineering Expt. Station, Georgia Institute of Technology, Atlanta, Georgia.

Vice Chairman: A. S. Perry, Food Consultant, 312 Ponce de Leon Ave., N. E., Atlanta, Georgia.

Secretary-Treasurer: Carroll F. Neff.

Councilor: J. G. Woodroof, Food Processing Division, Georgia Expt. Station, Experiment, Georgia.

The Honorable Phil Campbell, Commissioner, Georgia Department of Agriculture, and Mr. Paul Jolley, Director of the Inspection Division, were the speakers

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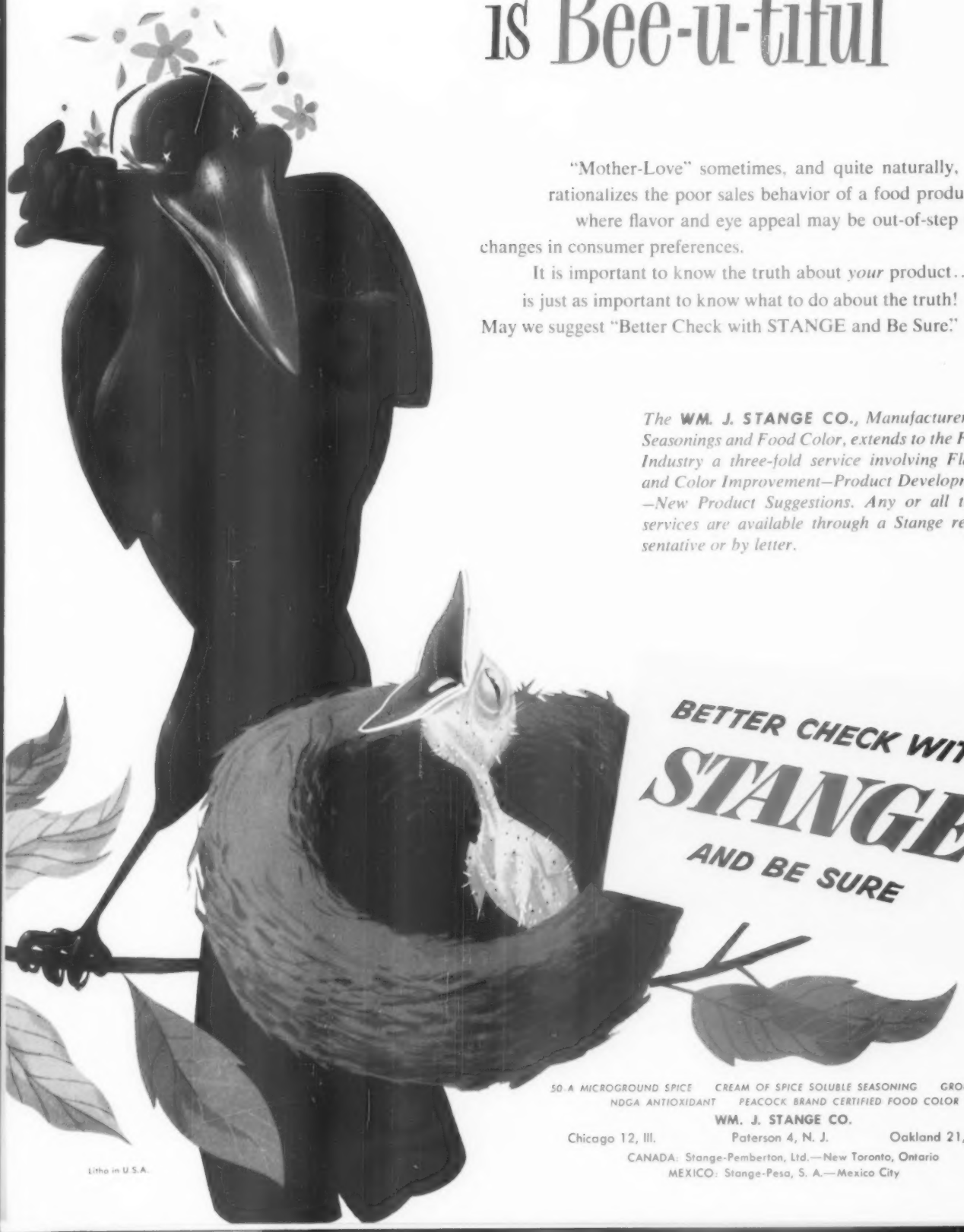
every old crow thinks her babe is Bee-u-tiful



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(Continued from page 18)

for the May 18th meeting which was held at the Cherokee Hotel, Atlanta. The topic was "Foods and Food Inspection in Georgia."

PHILADELPHIA . . .

The April meeting was held at the Ross House and was devoted to the celebration of the 50th Anniversary of the Federal Food and Drug Administration. Mr. C. S. Brinton, retired and former Chief of the Philadelphia District of the Federal Food and Drug Administration, presented an interesting review of the activities as a chemist when he worked with Dr. Wiley's "Poison Squad" prior to 1906. We were brought up to date on the activities of F. D. A. by six members of the Philadelphia District.

New officers elected for year 1956-57:

Chairman: E. C. Dryden.
Vice Chairman: John Crimmins.
Secretary: Norman Kramer.
Treasurer: Fred Jacobson.
Councilor: Rene Pouchain.
Alternate Councilor: Richard Foster.
Executive Committee: R. Mullan, L. Darlington, G. D. Boyd, A. D. Bowers.

Resolution to National IFT. Mr. Carl Pratt, Committee Chairman, reviewed a resolution which in the main requests the National President of IFT to appoint an ad hoc committee to study the possibilities of, and to make recommendations concerning, the establishment of a Food Industry "Contact" or Liaison committee for purposes of maintaining closer contact with the Federal Regulatory Agencies on problems of mutual interest. The resolution was approved and submitted to the National IFT.

May Meeting—Tour of Supermarket

On May 15, 1956, the Section met at Heller's Colonial Dining Room, 3729 Spruce Street. Mr. Paul Cook, Head of Store Operations, Penn Fruit Co., was the speaker. "Modern Supermarketing the Penn Fruit Way" was the title of his address. After the close of the talk, the meeting adjourned to the Penn Fruit Market at City Line Ave. and Conshohocken State Road for a conducted tour of the market. Store officials were on hand to answer questions during and after the tour. It was a pleasant and rewarding tour.

The final meeting of this year's activities was held at Heller's Colonial Dining Room on May 15. Theme of the evening was: "Merchandising of Food in the Super-Market."

Mr. Paul Cook, Head of Store Operations of Penn Fruit Co., a large supermarket chain, presented an interesting and informative talk on the various aspects of "supermarketing." In the selection of a location for such a store he related it was essential to extensively study the area for population densities and road access. A store in such a densely populated area usually relies on a half-mile radius for its greatest amount of business, and eight thousand families in the area are considered to be the minimum number to financially break even. In the Philadelphia area with one new supermarket opening every week, it was surprising to learn that individual independent stores still draw fifty percent of the available business. Other equally revealing aspects were that one and one-half percent net profit after taxes and eighteen percent gross profit were expected in such a supermarket operation. In a typical store, seventy-five percent of the business is done in less than two days, and there are approximately ten thousand different items available on the shelves. According to Mr. Cook, the transition from the small store to the supermarket was primarily the result of: (1) packaging revolution, (2) automobile driving by women, and (3) the presence of an efficient refrigerator in almost every home.

Following the talk the group was taken on a conducted tour of one of the newer Penn Fruit Supermarkets where we had the opportunity to hear Mr. Cook answer the questions of an enthusiastic, inquisitive group.

PERSONNEL

Two honors have recently been conferred upon Mr. John H. Nair of Thomas J. Lipton, Inc. Following the meeting of the professional group at Boston, May 9-11, he assumed office as president of the American Institute of Chemists. On May 17, he took office as president of the Association of Research Directors, a society composed of research administrators from seventy-five companies, located in the Eastern states, with research divisions having problems in common with regard to research administration.

Dr. Bruce H. Morgan was recently appointed Deputy for Radiation Preservation, Office of the Scientific Director, Quartermaster Food and Container Institute for the Armed Forces, Chicago. The position carries primary responsibility for the government effort in the radiation preservation of foods, it was announced, and includes not only that of the Department of Defense but of other agencies such as the Department of Agriculture, AEC, and the Department of Health, Education, and Welfare.

In recognition of his professional accomplishments during a distinguished scientific career, Dr. Charles N. Frey, former president of IFT and lecturer and consultant at the Massachusetts Institute of Technology, will receive the 1956 Honor Scroll of the New York Chapter of the American Institute of Chemists. Dr. Frey, for many years director of research and development of Fleischmann Laboratories, Standard Brands, Inc., receives the award at the AIC annual meeting, June 7, at the Commodore Hotel, New York City.

Dr. Clarence Sterling of the Department of Food Technology, University of California at Davis, will spend a sabbatical year in England and in Holland. His address in England will be the Department of Botany, The University, Leeds 2, England.

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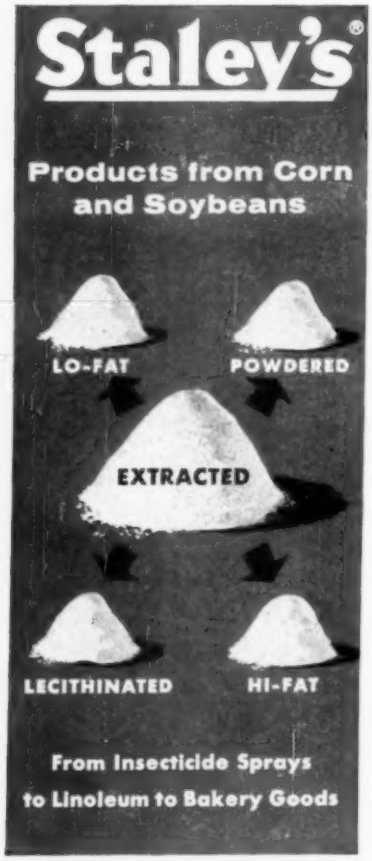

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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

Gas chromatography growing.

Chem. Eng. News, 34, 1692-6 (1956).

A discussion of the mechanism of vapor phase chromatography, the instruments manufd. for its application, and its present and potential uses. Its advantages of speed, low cost, and easily interpreted results reinforce its suitability for analysis of mixts. encountered in the food, chem., and petroleum industries. Prediction is that it will find wide application to continuous or intermittent plant process stream analysis.

A spectrophotometric method for the determination of cationic detergents.

Few, A. V., and Ottewill, R. H. (Dept. Colloid Sci. Cambridge Univ.). *J. Colloid Sci., 11,* 34-8 (1956).

Method depends upon formation of a complex between the detergent and an anionic dye, and the quant. extn. of the complex into an org. phase in which the dye itself is insol. The intensity of the color in the org. phase is then directly proportional to the concn. of detergent. Analysis is suitable for cationic detergents in aq. soln. at concns. of *ca.* 10^{-6} *M*; it is insensitive to wide variations in pH and salt concn. of the detergent soln.

Analysis of mixtures of the condensed phosphates by ion-exchange chromatography. II. Mixtures of ortho, pyro, tri-, tetra-, trimeta-, and tetrametaphosphates and Graham's salt.

Peters, T. V., and Rieman, W. (Ralph G. Wright Chem. Lab., Rutgers Univ., New Brunswick, N. J.). *Anal. Chim. Acta, 14,* 131-5 (1956).

When a mixt. of condensed phosphates is eluted on a column of Dowex-I with various concns. of KCl buffered at pH 5.00, appropriate fractions of the eluate contain (1) orthophosphate, (2) pyrophosphate, (3) triphosphate, (4) a mixt. of tetra- and tetrametaphosphates, and (5) trimetaphosphate. A similar elution with eluants buffered at pH 9.00 yields eluate fractions contg. (1) a mixt. of ortho-, pyro-, tri-, and tetraphosphates, (2) tetrametaphosphate, and (3) trimetaphosphate. In both elutions, Graham's salt is retained on the column until it is treated with HCl, thus two elutions serve for the detn. of the 7 constituents.

Rapid colorimetric methods for simultaneous determination of total reducing sugars and fructose in citrus juices.

Ting, S. V. (Florida Citrus Expt. Sta., Lake Alfred, Fla.). *J. Agr. Food Chem., 4,* 263-6 (1956).

The finding that fructose is completely oxidized in a carbonate-phosphate buffer contg. ferricyanide at 55° C., while glucose is not oxidized, is used to distinguish the content of these two sugars.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Significance of "heat-activated" enzymes.

Swartz, M. N., Kaplan, N. O., and Frech, M. E. (McCollum-Pratt Inst., Johns Hopkins Univ., Baltimore, Md.). *Science, 123,* 50-3 (1956).

A discussion of the mechanism of heat activation of enzymes with emphasis on the possible mechanism of cellular regulation involving the synthesis by the cell of specific enzyme inhibitors.

Chromatography of proteins. I. Cellulose ion-exchange adsorbents.

Peterson, E. A., and Sober, H. A. (Lab. Biochem., Natl. Cancer Inst., Bethesda, Md.). *J. Am. Chem. Soc., 78,* 751-5 (1956).

Describes the prepn. of ion-exchange adsorbents from cellulose under conditions such that phys. properties suitable for column chromatography are maintained. These adsorbents possess high capacity for the adsorption of proteins, yet permit elution under mild conditions. Titration curves are presented.

A simplified preparation of D-arginine.

Birnbaum, S. M., Winitz, M., and Greenstein, J. P. (Lab. Biochem., Natl. Cancer Inst., Bethesda, Md.). *Arch. Biochem. and Biophys., 60,* 496-8 (1956).

Renal acylase I was allowed to act upon acetyl-DL-arginine to produce AcOH, L-arginine and acetyl-D-arginine. Concn. of the digestion mixt. gave the very insol. acetyl-D-arginine in high yield and purity. Hydrolysis of the latter compd. with HCl yielded D-arginine-HCl nearly quantitatively.

Reactions of glucose with lysine.

Folk, J. E. (Natl. Inst. Health, Bethesda, Md.). *Arch. Biochem. and Biophys., 61,* 150-7 (1956).

The fluorodinitrobenzene method, in conjunction with paper chromatography and paper ionophoresis, was used to identify the sites of reaction of glucose with lysine and to measure the rates of reaction. During the storage of lysine with glucose at pH 8.5, 37° C., and 70% relative humidity, the α- and ε-amino groups of lysine reacted with glucose at equal rates. A large excess of glucose (8 moles/amino group) caused no change in reaction rates of the amino groups of lysine.

The reaction of wool keratin with alkali.

Blackburn, S., and Lee, G. R. (Wool Ind. Res. Assoc., Leeds, Engl.). *Biochim. et Biophys. Acta, 19,* 505-12 (1956).

Amino acid analyses on normal wool and wool treated with boiling alk. buffers have been made by the method of Moore and Stein. The only amino acid to undergo appreciable destruction was cystine; serine and threonine were destroyed to a

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smaller extent. Determination of lanthionine in a number of wools treated with alkali under differing conditions showed that for every cystine residue attacked during the alk. treatment one residue of lanthionine is produced. During the degradation of cystine, therefore, reactions other than lanthionine formation do not take place to any appreciable extent.

MICROBIOLOGY

Metabolism of carbohydrates by Pseudomonas saccharophila. II. Nature of the kinase reaction involving fructose.

PALLERONI, N. J., CONTOPOULOU, R., AND DOUDOROFF, M. (Dept. Bacteriol., Univ. Calif., Berkeley). *J. Bacteriol., 71,* 202-7 (1956).

Fructose-adapted mutant strains of *Pseudomonas saccharophila* contain a "mannose isomerase" which interconverts fructose and mannose. Fructose is phosphorylated with adenosine triphosphate to fructose-6-phosphate. The kinase is specific and distinct from the kinase (s) involved in the phosphorylation of glucose and mannose. Fructose-1-phosphate is not the initial product of phosphorylation and neither adenosine diphosphate nor glucose have a significant inhibitory effect on the reaction. Mannose can be phosphorylated slowly by fructose-adapted strains. The wild-type strain grown on maltose, which contained neither mannose isomerase nor fructokinase was shown to phosphorylate mannose to mannose-6-phosphate.

NUTRITION

The effect of low temperature and dietary calcium upon magnesium requirement.

HEGSTED, D. M., VITALE, J. J., AND McGRATH, H. (Dept. Nutr., Harvard Med. Sch., Boston, Mass.). *J. Nutr., 58,* 175-88 (1956).

Growth studies with weanling albino rats show that the Mg required per g. of diet to promote equal gains in wt. appears to be about 4 times higher at an environmental temp. of 55° F. than at 78° F. Since the max. rate of gain is less at the lower temp., the difference in the amt. required for max. gain is about twofold, .25 mg. per 100 gm. at 78° F. compared to 50 mg. per 100 gm. at 55° F. High Ca diets were detrimental at low Mg intakes.

Relations between diet and atherosclerosis among a working population of different ethnic origins.

EPSTEIN, F. H., SIMPSON, R., AND BOAS, E. P. (Res. Dept., Sidney Hillman Health Center, New York 3, N. Y.). *Am. J. Clin. Nutr. 4* (1), 10-19 (1956).

Data on the caloric and fat intake of an unselected working population are presented. Fat intake was related to the frequency of aortic atherosclerosis in men but not in women. Obesity *per se* did not appear to predispose to coronary or aortic atherosclerosis. Men but not women on a high fat diet showed higher serum chlosterol levels. Some aspects of the relation between diet and atherosclerosis are discussed.

Clinical use of sorbitol as a sweetening agent in diabetes mellitus.

SHUMAN, C. R., KEMP, R. L., COYNE, R., AND WOHL, M. G. (Temple Univ. Med. Sch., Phila., Pa.). *Am. J. Clin. Nutr., 4* (1), 61-7 (1956).

A palatable "ice cream" prepn. in which sorbitol was used as the sweetening agent in place of sucrose was fed to 38 diabetic patients. The slow absorption of sorbitol, and its conversion to fructose and glycogen prior to its availability as glucose had led to consideration of this substance for use as an adjunct in diabetic diets. In mild and moderately severe patients, the feeding of sorbitol ice cream as an addn. to the usual diet did not significantly alter the diurnal blood glucose values. It is possible that sorbitol ice cream may be permitted in the diet of the diabetic without substitution for its caloric equivalent.

Intestinal absorption and hepatic uptake of radioactive vitamin B_{12} in various age groups and the effect of intrinsic factor preparations.

GLASS, G. B. J., GOLDBLOOM, A. A., BOYD, L. J., LAUGHTON, R., ROSEN, S., AND RICH, M. (Dept. Med. and Gastroenterology Res. Lab. of N. Y. Med. Coll. Flower and Fifth Ave. Hosp., New York). *Am. J. Clin. Nutr., 4,* 124-33 (1956).

Measurement of the hepatic uptake of orally administered Co^{60}-labeled vitamin B_{12} in 60 individuals, 18 to 90 yrs. of age, showed a wide range of variation in the intestinal absorption of vitamin B_{12}. More individuals in the older group had an impaired intestinal absorption of vitamin B_{12}. The addn. of a potent intrinsic factor prepn. increased the hepatic uptake of radioactive vitamin B_{12} in almost one-half of the cases in all age groups. Especially notable was the increased hepatic uptake of individuals of the older age group having a decreased or abolished gastric acidity.

Vitamin B_{12} deficiency in vegetarians.

Nutr. Revs., 14, 73-4 (1956). Symptoms of vitamin B_{12} deficiencies have been noted in people who have been subsisting for years on a vegan diet. Children are apparently more adversely affected by the diet than adults.

What the homemaker knows about nutrition. II. Level of nutritional knowledge.

YOUNG, C. M., WALDNER, B. G., AND BERRESFORD, K. (Sch. Nutr., Cornell Univ., Ithaca, New York). *J. Am. Dietet. Assoc., 32* (3), 218-22 (1956).

Evidence indicates the homemaker knows more about nutritional values of meat, fish, and poultry, of potatoes, of other fruits and vegetables than about other items in the diet. They do not discriminate between values in different kinds of fruits and vegetables. Greatest need for more nutritional knowledge is in regard to: ascorbic-acid-rich fruits and vegetables; carotene-rich fruits and vegetables; adult need for milk; nutritional value of breadstuffs and cereals and of butter and fortified margarine.

Lysine and tryptophan content of proteins and their utilization for human growth.

ALBANESE, A. A., HIGGONS, R. A., HYDE, G. M., AND ORTO, L. *Am. J. Clin. Nutr., 4,* 161-8 (1956).

Data are presented to show that the carcass analysis procedure proposed by Mitchell may be valid for evaluating human growth needs for some essential amino acids. Available evidence indicated that the utilization of proteins increased as their lysine and tryptophan content approached that of muscle tissue, lysine/tryptophan (L/T), value of 6.3. Also, the nutritive value of some products with a low L/T ratio was improved by small addns. of lysine. Improved nutrition in terms of body wt. change generally occurred in a total of 27 infants when L/T ratios of 6.0-7.0 were maintained by lysine administration to diets which provided a min. of 100 cal. and 3.5 gm. of protein per kg. per day. Lysine supplementation of wheat gluten increased its nutritive value to that of milk proteins.

Canine and human gastric digestion of proteins in vivo.

NASSET, E. S., AND DAVENPORT, A. *J. Appl. Physiol., 7,* 447 (1954); *Am. J. Clin. Nutr., 4,* 188-9 (1956).

When gastric juice was collected from dogs, at least 15 microbiologically available amino acids were present. Although lysine and tryptophan are absent from zein, they were always found in gastric contents, no matter what protein test meal was fed. A rather complex mixt. of amino acids is, therefore, presented to the duodenum from the stomach. Part of these are secreted as free acids. Hydrolysis of ingested protein, as well as enzymes and proteins present in saliva and gastric juice also furnish amino acids.

Dental caries in the albino rat in relation to the chemical composition of the teeth and of the diet. II. Variations in the Ca/P ratio of the diet induced by changing the phosphorus content.

WYNN, W., HALDI, J., BENTLEY, K. D., AND LAW, M. L. (Dept. Physiol., Emory Univ., Ga.). *J. Nutr., 58* (3), 325-33 (1956).

Quadruplicate groups of litter mate albino rats were fed from weaning on cariogenic diets in which 4 different Ca/P ratios were tested; the ratio was changed by maintaining the Ca concn. at a const. level and varying the P. In one expt. in which the animals were desalivated, there was a progressive decrease in the caries score as the Ca/P ratio was decreased from 1:0.5 to 1:2. In a second expt. in which the animals were not desalivated in order to avoid the complications of caries over the same feeding period, the N, Ca, P, Mg, fluoride and CO_2 content of the teeth was the same on each of the

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4 diets. The effect of varying the Ca/P ratios of the diet on its cariogenicity was, therefore, not related to changes in the compn. of the teeth.

Placental transfer of calcium in the rat.

FEASTER, J. P., HANSARD, S. L., OUTLER, J. C., AND DAVIS, G. K. (A.E.C. Agr. Res. Program, Oak Ridge, Tenn.). *J. Nutr., 58* (3), 399-406 (1956).

Ca^{45} administered orally to pregnant rats was found to cross the placenta and deposit in the fetus at all stages of gestation studied, from the 14th to the 22nd day. The amt. of labeled Ca transferred from dam to fetus in a given length of time after administration increased with increasing fetal age. The findings indicate that a part of the Ca transferred to the fetus must have been derived from Ca previously stored in the maternal skeleton.

Diet and lipogenesis in adipose tissue.

Nutr. Revs., 14, 81-2 (1956).

The glucose utitlization of adipose tissue after fasting or the feeding of diets of varying fat content was investigated. Both lipogenesis and glucose oxidation were diminished in adipose tissue by fasting or by feeding a high fat diet (60% fat 1.2% carbohydrate). Dietary carbohydrate, in the form of sucrose, stimulated lipogenesis and glucose utilization. The finding that dietary fat (35%) inhibits lipogenesis by adipose tissue even in the presence of considerable dietary carbohydrate may prove of importance in attacking the obesity problem.

The absorption of plant sterols and their effect on serum and liver sterol levels.

SWELL, L., BOITER, T. A., FIELD, H., AND TREADWELL, C. R. (Gen. Med. Res., Veterans Adm. Center, Martinsburg, W. Va.). *J. Nutr., 58* (3), 385-98 (1956).

Rats were fed synthetic diets contg. 25% of oleic acid, 1% of Na taurocholate, and 2% of soybean sterols in various combinations. On a fat-free diet virtually all of the plant sterols could be quantitatively recovered in the feces. When 1% of Na taurocholate was added to the fat-free diet, 15.7% of the sterols ingested were absorbed (25 mg/day). Addition of 25% of oleic acid to the basal diet also promoted the absorption of the plant sterols (15.5% of the amt. fed, or 24 mg/day). The serum sterols increased in the groups fed plant sterols with oleic acid or oleic acid and bile salts. The addn. of oleic acid and bile salts to the diet produced the highest elevation of the serum sterols (104.4 mg %). The data in the present study suggest that plant sterols are absorbed through the same mechanism as cholesterol and may be converted to cholic acid, cholesterol, or a cholesterol intermediate in the intestine or liver.

Nutritional requirements of isolated mammalian cells.

Nutr. Revs., 14, 89-90 (1956).

Two types of cells were cultivated under *in vitro* conditions, a human uterine carcinoma cell and a mouse fibroblast. Cells were grown in a semisynthetic media. The following 13 amino acids were required by both cells; omission of which caused death: arginine, cysteine or cystine, glutamine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, tyrosine and valine. Necessary vitamins were choline, folacin, niacinamide, pantothenate, pyridoxine, riboflavin and thiamine. None of the fat sol. vitamins were required. Glucose was the most effective carbohydrate source. Ions required were Na^+, K^+, Mg^{++}, Ca^{++}, Cl^-, and $H_2PO_4^=$.

A dietary defect in maize developed during treatment with lime.

PELLET, P. L., AND PLATT, B. S. (Med. Res. Council Labs., Hampstead, N. W. 3 Engl.). *Nature, 177*, 422-4 (1956).

Substitution of lime-treated for whole maize meal has the following advantages (1) increase in Ca, (2) increased proportion of unbound nicotinic acid (although actually decreasing the total amt. of nicotinic acid) and (3) increasing digestion and absorption of the meal. The lime-treated maize however, has the disadvantage of reduction of riboflavin and thiamine.

Mechanism of weight loss by amphetamine.

Nutr. Revs., 14, 71-2 (1956).

A series of regulated studies have been carried out on human subjects and dogs to det. the true explanation for amphetamine induced wt. losses. In one expt. 7 obese and 2 nonobese human subjects were fed 3 meals a day *ad libitum* for 2 eight-wk. periods, sepd. by a 4-wk. vacation, and were given either 5 mg. of D- or 10 mg. of DL-amphetamine 1 hr. before meals, during the second half of each 8-wk. period. Both voluntary caloric intake and body wt. were reduced. 5.87 lbs. av. were lost in first 8-wk. expt. and 5.50 lbs. over 4 wks. in second expt. Results with dogs were similar. All loss of body wt. was accounted for in terms of caloric deficiency of intake rather than caloric energy expenditure. Side effects are relatively few; the most common being restlessness and insomnia.

Adverse effects of some amino acid supplements in low-protein diets for growing dogs.

GESSERT, C. F., AND PHILLIPS, P. H. (Dept. Otolaryngology, Med. Sch., Washington Univ., St. Louis, Mo.).

It is concluded that caution should be used in trying to improve low-protein diets for young, growing dogs by the addns. of single amino acids. The av. gains in wt. of 8 or 9 pups per group for 10 or 12 wks. showed that an individual supplement of either L-lysine or DL-methionine caused a retardation in the growth which was already suboptimal. When both of these amino acids were added simultaneously, the growth repression caused by either alone was overcome by the combination, and in one instance

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the growth was greatly improved over that obtained with the basal diet alone. These observations are interpreted as showing evidence of the importance of amino acid balance in low protein diets for growing dogs.

Protein in the nutrition of the growing dog.

GESSERT, C. F., AND PHILLIPS, P. H. (Dept. Otolaryngology, Sch. Med., Washington Univ., St. Louis, Mo.). *J. Nutr., 58* (3), 415-21 (1956).

The protein requirement for growth of young dogs was investigated by adding increments of casein to a basal diet which contained 10.6% of protein (*N X* 6.25), and was adequate in other nutrients. The other 4 diets contained 12.8, 15.0, 17.2 and 19.4% of crude protein respectively. The basal diet sustained health and a retarded rate of growth in the young dogs. There was a correlation between the comparative gains in body wt. and the comparative protein contents of the diets from 12.8 to 17.2% of protein, beyond which pt. there was no further increase in growth rate caused by addnl. protein. Since the diet contg. 17.2% of protein was adequate for the growth of the pups, their requirements for the 10 essential amino acids apparently do not exceed the amts. that it contained. A 5½-mon. old pup which was very retarded in growth for 4 mons. by a protein deficiency was still able to grow at a normal rate when his dietary protein was raised to 17.2%.

Effect of dietary cobalt on growing chicks and rats.

BURNS, M. J., AND SALMON, W. D. (Dept. Animal Husbandry and Nutr., Alabama Polytechnic Inst., Auburn). *J. Agr. Food Chem., 4*, 257-9 (1956).

Dietary Co is nutritionally important for nonruminants fed diets inadequate in choline and vitamin B_{12}.

Relation between caloric intake, body weight, and physical work: Studies in an industrial male population in West Bengal.

MAYER, J., ROY, P., AND MITRA, K. P. (Dept. of Nutr., Harvard Sch. Public Health, Boston, Mass.). *Am. J. Clin. Nutr., 4*, 169-75 (1956).

A group of 213 mill workers, engaged in sedentary and very hard work, were surveyed in West Bengal. There was a striking parallelism between the findings in the individuals tested and those in animals. Food intake increased with activity up to a certain point. There was a zone, however, where a decrease in activity was followed by an increase, rather than a decrease, in food intake. Body wt. was also increased in that zone.

PHYSIOLOGY AND MEDICINE

The glucose tolerance test in swine and its implications.

BUNDING, I. M., DAVENPORT, M. E., AND SCHOOLEY, M. A. (Veterinary Res. Dept., Armour Labs., Chicago, Ill.). *J. Animal Sci., 15*, 234-41 (1956).

Data are presented to indicate that a "diabetic-like" syndrome may exist in adult swine. Of 24 animals studied, 3 gave a diabetic type of blood glucose tolerance curve.

Glucose tolerance in relation to obesity and food intake.

BLOOM, R. A., AND FENTON, P. F. (Dept. Biology, Brown Univ., Providence, R. I.). *Am J. Physiol., 184*, 438-40 (1956).

Glucose tolerance tests were carried out on two strains of mice, one highly susceptible, the other only moderately susceptible to nutritional obesity. With glucose administered on the basis of body wt. or fat-free wt., the highly susceptible strain disposed more rapidly of the administered glucose than did the moderately susceptible strain. Fasting blood sugar levels in both strains were found to increase with the logarithm of body wt. These observations are not readily explained in terms of the "glucostatic" theory of the control of food intake.

Metabolism of lactic acid in the intact rabbit.

DRURY, D. R., AND WICK, A. N. (Dept. Physiol., Med. Sch., Univ. Southern California, Los Angeles). *Am. J. Physiol., 184*, 304-8 (1956).

The metabolism of the lactic acid was studied in normal intact rabbits making use of C^{14} labeled L (+) lactate. The circulating lactate is being used up and renewed at a rapid rate. The turnover time is about 30 mins. Eighty to 90% of the lactate is disposed of by direct oxidation. Only a small percentage can be accounted for as glucose, glycogen and by the oxidation of these. Lactate that is produced in emergency states can serve as a quick fuel for vital tissues in these situations.

ENGINEERING AND PLANT EQUIPMENT

Edible products in pressurized dispensers.

HERZKA, A. (Res. Div., Metal Box Co. Ltd., Kendal Ave., London). *Chemistry & Industry, 1*, 6-8 (1956).

A comprehensive, nontechnical review of the types of dispensers, methods of filling and propellants used with particular reference to the food industry.

Theory and practice of continuous pressure filtration.

NICKOLAUS, N., AND DAHLSTROM, D. A. (Research and Development, The Eimco Corp. Palatine, Ill.). *Chem. Eng. Progress, 52* (3), 87-93 (1956).

A review of theory and practice of continuous pressure filtration indicating in what situations it is useful, its mode of operation, its advantages, the type of auxiliary equipment required and methods of predicting capacity requirements and product quality.

Process design data. First steps in process design. VI. Liquid-liquid equilibrium and gas solubility data.

JOHNSON, A. I., CHEN-JUNG HUANG, AND BARRY, T. W. *Chemistry in Can., 7*, 39-42, Sept. 1955; *Battelle Tech. Rev., 4* (11), No. 13588 (1955).

Correlations proposed can be used for storing and extrapolating data, and indicate methods of correlation which may be applied to other systems.

Recording smokemeter for fish and bacon curers.

JASON, A. C. (Torry Res. Sta., D.S.I.R., Engl.). *Food Manuf., 31* (3), 112-3 (1956).

To meet the needs of smoke cured products, the Torry Res. Sta. (Engl.) has constructed an optical instrument for recording and measuring the density of wood smokes. The design of the instrument and its operation are described in this article.

FOOD AND FOOD TECHNOLOGY

FATS AND OILS

The estimation of 1-monoglyceride.

DOWSE, C. M., AND SAUNDERS, J. A. (Dept. Physiol., Med. Sch., King's Coll., Newcastle, Engl.). *Biochem. J., 62* (3), 455-8 (1956).

A method based on the estn. of formaldehyde formed during periodic acid oxidation of 1-monoglyceride, is described.

Methanolysis of monoglycerides during urea adduct formation.

AYLWARD, F., AND WOOD, P. D. S. (Dept. Chem. and Food Technol. Borough Polytechnic, London). *Chemistry & Industry, 46*, 1479 (1955).

Authors report that due to crystn. of the urea inclusion compd. of Me stearate, in preference to that of glyceryl monostearate, over a period of 17 hrs., the equil. glyceryl monostearate + MeOH $\rightleftarrows$ Me stearate and glycerol, had been displaced to the right thereby resulting in greatly decreased yield of the monoglyceride. By processing hastily this loss was avoided.

MILK AND MILK PRODUCTS

A new type home pasteurizer.

HERREID, E. O. (Ill. Agr. Expt. Sta.). *J. Milk and Food Technol., 19* (3), 76-9 (1956).

An immersion type two-gallon home pasteurizer is described. It has features that make it possible to properly pasteurize milk in the home. This unit is simple, efficient and easy to operate.

SUGARS AND STARCHES

The effect of sucrose on the properties of some starches and flours.

HESTER, E. E., BRIANT, A. M., AND PERSONIUS, C. J. (Dept. Foods and Nutr., Pennsylvania State Univ., Univ. Park). *Cereal Chem., 33*, 91-101 (1956).

In the presence of sucrose, the hydration of starch granules was inhibited. Sucrose influenced paste and gel properties.

INDUSTRIAL HEALTH

Mercury exposure in a university laboratory.

GOLDWATER, L. J., KLEINFELD, M., AND BERGER, A. R. (Sch. Public Health, Co-

(Continued on page 30)

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(Continued from page 28)

lumbia Univ., N. Y.). *Arch. Ind. Health, 13* (3), 245-9 (1956).

A case of Hg poisoning occurring to a lab. worker operating a Hg diffusion pump is reported. Environmental studies revealed potential sources of danger to Hg poisoning which were amenable to simple control measures.

Toxicity of ethylene oxide determined on experimental animals.

HOLLINGSWORTH, R. L., ROWE, V. K., OYEN, F., MCCOLLISTER, D. D., AND SPENCER, H. C. (Biochem. Res. Dept., Dow Chem. Co.). *Arch. Ind. Health, 13* (3), 217-27 (1956).

A review of the toxicological literature on ethylene oxide is presented. An industrial hygiene standard of 50 p.p.m. is suggested for ethylene oxide. Practical considerations in handling and use of the subject material are discussed. Ethylene oxide appears to be about 3 times as toxic as propylene oxide by inhalation and ingestion for all animals species studied. The 2 materials are similar in their effects upon the eyes and skin of rabbits.

PHYSICAL RESEARCH

Ion-exchange materials and their applications in industry.

KRESSMANN, T. R. E. (The Permutit Co. Ltd., Gunnersbury Ave., London). *Chemistry & Industry, 3*, 64-9 (1956).

Review of the industrial uses of ion-exchange resins with particular emphasis on H_2O purification, catalysis and recent developments which utilize ion-exchangers as membranes in the electrodialytic desalting of brackish waters.

The movement of moisture through solids.

BABBITT, J. D. (ASTM Headquarters, 1916 Race St., Phila. 3, Pa.). *ASTM Bull., 212*, 58-61 (1956).

A review of the various phys. concepts which relate to the movement of moisture through solids, analyzing moisture movement in its six possible states—vapor, liquid, solid, chem. compound, adsorbed, and dissolved.

Infra-red absorption spectra and protein-sugar interactions.

GOULDEN, J. D. S. (Physics. Dept., Natl. Inst. Research in Dairying. Univ. of Reading, England). *Nature, 177*, 85-6 (1956).

The infra-red spectra for lactose-casein in a dry mixt. and for lactose-casein freeze dried from aq. soln. are different. The author believes that these differences are due to H bonding in the later case and that this is the first stage in the browning reaction between lactose and casein.

A survey of United States butterfat constants. I. Reichert-Meissl, Polenske, and refractive index values.

ZEHREN, V. L., AND JACKSON, H. C. (Dept. Dairy and Food Industries, Univ. Wisconsin, Madison). *J. Assoc. Offic. Agr. Chemists, 39*, 194-212 (1956).

Reichert-Meissl, Polenske, and refractive index values were det. monthly for one year on butterfat obtained from 42 sources from 6 geographical areas having a coverage of 25 states. The statistical analysis showed that the significance of the monthly variation of the av. fat constant values was different for the individual areas.

RADIOCHEMICAL TECHNOLOGY

Glass dosimetry.

DAVISON, S., GOLDBLITH, S. A., AND PROCTOR, B. E. (Dept. Food Technol., Massachusetts Inst. Technol., Cambridge, Mass.). *Nucleonics, 14* (1), 34-9 (1956).

A thorough study of silver phosphate glass as a dosimeter: The effects of storage temp., post irradiation heat treatment, freezing temps. during irradiation and other parameters.

Termination report. I. Food irradiation and associated studies.

Columbia Univ. (U. S. Atomic Energy Commission), NYO-3320, 47 (1954) (UF767 U3ny); *Battelle Tech. Rev., 5* (3), No. 2179 (1956).

Contains 5 papers dealing with: effect of irradiated diet on rats; oxidative deterioration in irradiated milk; effect of γ-radiation on fats; and γ-ray oxidation of ascorbic acid and ferrous ion.

PATENTS

Vitaminized products.

Brit. 744,091, February 1, 1956.

Vitamin-active substances are incorporated in an aq. dispersion of a protein which may contain lipidic, glucidic, and mineral substances and coagulation of the protein then effected with a nontoxic chem. coagulant so that the coagulum encloses the active substances, and the coagulum is dried as quickly as possible after it was produced. The vitaminized products so obtained can be mixed with such as cattle foods.

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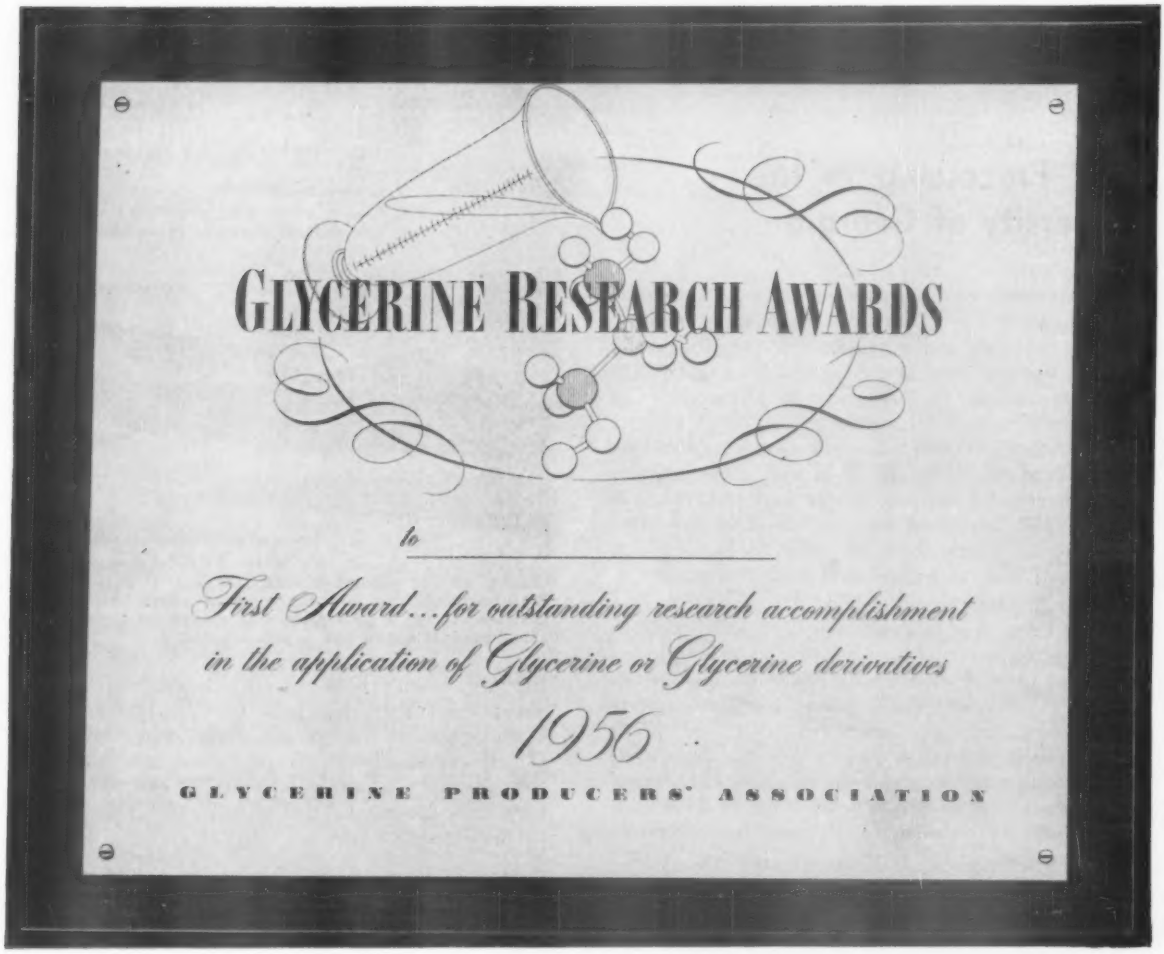
(Continued on page 59 following technical papers)



Announcing the 1956 Glycerine Research Awards

FIRST AWARD	Honor Plaque	$1,000
SECOND AWARD	Honor Certificate	$300
THIRD AWARD	Honor Certificate	$200

The purpose of this group of awards, established in 1952 by the Glycerine Producers' Association, is to recognize and encourage research leading to new and improved applications of glycerine or glycerine derivatives to products or processes. The work may concern itself with the chemical, physical or physiological properties of glycerine, or with properties of glycerine-containing or glycerine-derived materials. It may deal with applications which of themselves are currently or potentially of value to industry or the general public, or it may deal with scientific principles or procedures likely to stimulate future application. Originality in extending the application of glycerine into new fields of usefulness will receive special consideration for awards.

BASIS OF ENTRY

These awards are open to any individual in the United States and Canada engaged in research, whether employed in industry or affiliated with a governmental or educational institution (faculty or college student) except those connected with member companies of the Glycerine Division, Association of American Soap & Glycerine Producers, Inc., or laboratories which they employ. (Joint entries by research teams or associates of two or three individuals are also eligible.)

PERIOD OF AWARD

First consideration for the 1956 Award will be given to work which has come to a successful conclusion or clear-cut point of accomplishment during the current year, regardless of the date at which the work was initiated. Work carried on in previous years, but the significance of which has been confirmed by commercial application in 1956, will be eligible.

JUDGES

Selection of award winners will be made by a committee of three judges of outstanding reputation and appropriate scientific background, having no connection with the Association or its members.

DATE FOR NOMINATIONS

All nominations for the 1956 awards must be received by *November 1, 1956.*

METHOD OF NOMINATION

Only nominations made on the official entry blank will be eligible for awards. For a copy of this official entry blank, write to: *Awards Committee, Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.*

FEATURING THIS MONTH . . .

Food Processing in the University of Georgia

J. G. Woodroof
Chairman, Division of Food Processing,
University of Georgia, Experiment, Georgia

THE DIVISION OF FOOD PROCESSING in the College of Agriculture of the University of Georgia, includes teaching, research and extension. A Department for research was organized at the Georgia Experiment Station, Experiment, in 1940; and a Department for teaching was formally organized at the College of Agriculture, Athens, in 1944.[a] In 1950 these were combined into a Division, and specialists in food preservation of the Agricultural Extension Service were included. The work is well integrated and reaches farm and urban people on all levels, from the home to various community activities, as well as commercial enterprises.

Research projects. The bulk of the research work in Food Processing is aimed at helping solve problems of Georgia farmers and homemakers, but other projects are aimed to solve problems in relation to frozen food lockers, commercial freezing plants, refrigerated warehousemen, canners, preservers and other food processors. Several projects in cooperation with commercial companies in connection with the use of special products or processes have been conducted. One of these is the study of the use of corn syrups as sweeteners for canned sweet potatoes, frozen peaches, and berries. Another project which was conducted in cooperation with commercial companies was the use of lye for peeling fruits and vegetables.

More than half of the money expended for research in Food Processing has been from federal funds. The remaining monies come from state appropriations, commercial companies and the sale of products. Among agencies sponsoring projects in the Division of Food Processing in recent years are: The Refrigeration Research Foundation, The Quartermaster Food and Container Institute, Corn Industries Research Foundation, A. E. Staley Manufacturing Company, The Solvay Process Company, The National Confectioners Association, and The New England Confectionery Company.

The bulk of the research work in this Division is conducted at Experiment. The facilities there include a pilot plant with two production lines with a capacity of about one-half ton of product per day (Figure 1).

Figure 1. A general view of the Food Processing building housing offices, research laboratories and a pilot plant at Experiment. It contains six complete offices, five complete laboratories, and a pilot plant with a capacity for processing about one-half ton of raw products per day.

Products which may be run are peaches, sweet potatoes, muscadine grapes, field peas, beans and others. Most of the equipment was specially made for this laboratory. Closely connected with the pilot plant is a quality control laboratory, a taste panel room, an instrument room for testing special qualities in foods, as well as a chemical laboratory for analyses (Figure 2).

Figure 2. General view of the chemical laboratory in the Food Processing Building at Experiment.

While the major part of the research program is located at Experiment, several research projects are located in Athens also. Following are a few projects studied in recent years:

Frozen foods. The project receiving the most attention for the past twenty years has been that of frozen foods. This had its beginning in 1928 and has continued since that time. More than fifty technical reports have resulted from studies on microscopical examinations of frozen foods, effect of rate of freezing on quality of

(Continued on page 38 following technical papers)

[a] Heading the Division, as well as the Department at Experiment, is Dr. J. G. Woodroof (horticulturist); who has associated with him S. R. Cecil (chemist); Cordelia Ellis, E. K. Heaton, H. R. Malcom, and M. L. Williams (food technologist); Barbara Cowan and Ethyl Shelor (home economists); and Naomi Woodroof (pathologist). All of these devote full time to research.

The teaching work at Athens is headed by Dr. J. J. Powers, who also directs several research projects. Associated with him are Dr. G. J. Banwart and Dan Pratt (all food technologists). Heading the work in extension is Miss Eddye Ross. Others in this field are Miss Mary Gibbs, Miss Viola Rickett, and Miss Nell Boyd (all home economists) and located in Athens.

The Effects of Various Sweetening Agents On Frozen Strawberries for Preserve Manufacture[a]

M. Aref,[b] A. P. Sidwell,[c] and E. M. Litwiller[d]

Food Technology Department, Oregon State College, Corvallis, Oregon

(Manuscript received September 6, 1955)

CRUESS, OVERHOLSER, AND BJARMASON *(1)* were among the first to report on the benefit gained by the addition of sugar sirup to apricots, cherries, and berries before freezing. Joslyn *(10)*, Diehl *(6)*, Woodroof *(17)*, and Wiegand *(16)* agreed that sugar acts as a preservative as well as a flavoring agent, and affects the retention of the natural color, flavor, and aroma of the frozen fruit. Additional gains cited were firming of the tissues of fruits designed for further processing subsequent to freezing, and the retardation of discoloration of the tissues upon exposure to air.

The sugar used in the early investigations was generally cane sugar (sucrose), and Joslyn *(10)* was probably the first to investigate other sugars (sweeteners). His investigations were reported to have shown that sucrose was preferable to dextrose for addition to frozen fruits. Joslyn and Hohl *(11)* reported later that substitution of dextrose solutions, invert sirup, or honey for cane or beet sugar solutions had not been found desirable.

Recently, Gilbert *(8)* reported that capping fresh strawberries, apricots, and peaches with granular Frodex[e] prevented oxidation of fruit during thawing and prior to subsequent use, and enabled production of preserves with flavor, color, and texture superior to those made from 4:1 sucrose packs. The 4:1 sucrose packs, however, resulted in the production of preserves superior to those produced from a 4:1 Frodex pack suggesting the possibility of beneficial effects of capping per se.

This investigation was initiated to determine whether or not the addition of various sweeteners to strawberries, prior to freezing, would affect the fruit differently with respect to quality characteristics and performance when subsequently manufactured into preserves.

EXPERIMENTAL PROCEDURES

General. Three lots of Marshall strawberries from 3 different localities in Oregon were used in these experiments. Nine different treatments were made to each lot except lot III to which an additional treatment was added. The treatments are explained in Table 1.

The berries were packed in 10-pound, friction-top cans, and were frozen and stored at 0° F. (—17.7° C.) until opened for examination.

The vitamin C content, acidity, total solids, and pH of the berries were determined. The vitamin C content varied between 62.8 and 88.5 mg./100 g., the acidity varied between 0.70 and 1.03% on the anhydrous citric acid basis; the soluble solids varied between 8.0 and 9.8%, and pH from 3.50 to 3.62.

TABLE 1

Different treatments used in preparing the frozen strawberries

Lot no.	Treatment code	Sweetener used	Fruit : sweetener ratio
I, II & III	S 4	100% Sucrose	4:1 hand-mixed
I, II & III	SD 4	75% Sucrose + 25% Dextrose[f]	4:1 hand-mixed
I, II & III	SF 4	75% Sucrose + 25% Frodex	4:1 hand-mixed
I, II & III	F 4	100% Frodex	4:1 hand-mixed
I, II & III	S 6	100% Sucrose	6:1 hand-mixed
I, II & III	SD 6	75% Sucrose + 25% Dextrose	6:1 hand-mixed
I, II & III	SF 6	75% Sucrose + 25% Frodex	6:1 hand-mixed
I, II & III	F 6	100% Frodex	6:1 hand-mixed
I, II & III	FC 9	100% Frodex	9:1 cap
III	SC 9	100% Sucrose	9:1 cap

[f] As Cerelose, trade name of a product manufactured by the *Corn Products Refining Company*, New York, New York.

The frozen berries were examined after 3 months' and after 6 months' storage. The same determinations were made as for the fresh berries, and in addition, drained weights were determined, color was measured, and appearance was judged.

At the end of the 3 months' and 6 months' storage periods, two 10-pound cans of each treatment of each lot of the frozen berries were separately made into two batches of preserves. The preserves were made in a steam-jacketed open kettle, with the addition of the necessary amounts of sucrose and pectin to approximately equal soluble solids. The natural acid content of the berries was sufficient for the proper setting of the preserves, and no attempt was made to compensate for the small differences in the final sweetness resulting from the sweeteners initially added to the berries. These preserves were evaluated for flavor and wholeness of the fruit, the color was measured, and invert sugar was determined.

Drained weight determination. The frozen berries were thawed at about 72° F. (22.2° C.) exactly 24 hours, the 10-pound can was emptied evenly on a circular, flat-bottomed basket of 8-mesh wire screen, 18 inches in diameter, and the berries were drained for 3 minutes into a pan fitting the basket exactly. Both the drained berries and the drip were weighed separately, their combined weights considered as the total weight, and percentage drained weight calculated.

Frozen strawberry appearance evaluation. The berries were thawed as described, and the contents of each can transferred into a large bowl, a representative sample taken into a white porcelain dish, and the dishes lined at random on a well-lighted bench. The judges were asked to rank the samples according to their appearance, without further explanation. Later interviews with individual judges revealed, however, that the criteria used for judging the appearance were the degree of disintegration of the fruit and consequently the clearness of the liquor surrounding the strawberries. Color was not considered by the judges as they could not detect any differences. A panel of 12 judges was used throughout this test, and all the treatments of each lot were judged in duplicate.

Frozen strawberry color measurement. After thawing the berries as described, their color was immediately measured on the Hunter Color and Color Difference Meter, using the "L" scale. A representative sample was taken from each can, placed in a circular transparent clear plastic dish, and 4 spot readings taken at random. Two cans per treatment were used for color evaluation.

Vitamin C determinations. Vitamin C was determined by a modification of the colorimetric method using sodium 2,6-dichlorobenzenonindophenol *(13)*. Two determinations were run on each of 2 cans from each treatment in all 3 lots of berries after 6 months of storage at 0° F. (—17.7° C.), and the results adjusted for the different ratios of sweeteners. Two jars from

[a] Technical Paper No. 917, Oregon Agricultural Experiment Station. This project was financed in part by a grant from the Sugar Research Foundation, Inc.

[b] Now at Food Technology Department, University of Alexandria, Egypt.

[c] Now at Quality Evaluation Section, A.M.S., U.S.D.A., Beltsville, Maryland.

[d] Food Technologist, Oregon Agricultural Experiment Station.

[e] Trade name of a corn sirup solids product manufactured by the *American Maize-Products Company* of New York, N. Y.

each treatment of each lot of the preserves made after 6 months of the frozen storage of the strawberries were used separately for the vitamin C content determinations.

Wholeness of the strawberries in preserves. A panel of 12 judges ranked different combinations of the preserves according to the wholeness of the fruit they contained. The preserves were poured from the jars into porcelain dishes without mixing, and the judges were asked to disregard factors other than wholeness of fruit. Twenty-seven tests were run on different combinations of preserves made from each of the 3 lots of strawberries after 3 and after 6 months' frozen storage.

Flavor evaluation of the preserves. A panel of 12 judges was used throughout the flavor evaluation work to rank the different preserves according to acceptability. Two fairly large college student panels were also used twice to rank the different preserves. A total of 28 tests was run on different combinations of the preserves.

Color evaluation of the preserves. Two 12-oz. jars from each treatment were used for every determination on the Hunter instrument. The preserves from one jar were thoroughly mixed, poured into 2 plastic dishes, and one reading taken on each dish resulting in 4 readings for each treatment. All determinations were run in duplicate and readings converted to "dominant wavelength" and "purity."

In addition, two 12-oz. jars from each treatment of each lot of the preserves made after 6 months were submitted in duplicate to an official inspector from the Agricultural Marketing Service (hereafter abbreviated "A.M.S."), to be scored for color only. The 112 jars were all coded at random.

Invert sugar determinations. Invert sugar was determined in the preserves made after 6 months of storage using the Lane-Eynon volumetric method *(1)*. The modification of the Reifer and Melville aqueous, Waring blender, extraction procedure *(14)* developed by Kitson *(12)* was used for extraction of the sweeteners throughout this work.

One complete batch of the preserves was used in the determinations which were all run in duplicate. The amount of invert sugar in every case was subtracted from the corresponding total sugar content and the product divided by the invert sugar to obtain the sucrose : invert sugar ratio.

Statistical analysis. In cases where all the treatments from the 3 experimental lots were compared, analyses of variance were run on the 9 treatments having factorial relationship in each case. The lot x treatment interaction mean square was used as error. Whenever the effect of treatments was found significant, the same error was used to determine the L.S.D. for lot III only to include the extra treatment, SC-9.

In all cases where the ranking technique was used for product evaluation, the ranks were transformed to scores according to Fisher and Yates *(7)*. In all cases where the Hunter Color and Color Difference Meter was used, the National Bureau of Standards red plaque SKC-51 was used as the standard. Transformations to the C.I.E. system *(5, 9)* were made where appropriate.

RESULTS

Effects on drained weight. The effects of lots, treatments, sugars and ratios were significant at the .01 level of probability.

When only the 8 treatments in which the sweeteners were hand-mixed were compared, it was evident that both the sweeteners and the ratios used exerted significant differences (Table 2). Regardless of ratio, the use of Frodex in this manner resulted in significantly lower drained weights, the use of sucrose resulted in the highest drained weights, while the substitution of only 25% of the sucrose with either dextrose or Frodex did not lower the drained weights significantly. Regardless of sweetener used, the 6 : 1 ratio resulted in significantly higher drained weights than the 4 : 1 ratio.

Effects on appearance of the frozen berries. Significant differences in appearance were found to be due to treatment only. Capping resulted in superior appearance regardless of the sweetener used; while hand-mixing with Frodex resulted in the least desirable appearances.

Effects on Hunter color values of the strawberries. The Hunter "L." readings and the dominant wavelengths after 3 months of storage were significantly different due to lots, treatments, and sweeteners, while the purity values were significantly different due to lots only.

TABLE 2

The effects of treatments, sweeteners, and sweetener ratios on percentages drained weight of frozen strawberries after 6 months' storage at 0° F. (—17.7° C.)

Treatment	Drained wt. %		Sweetener	Drained wt. %		Sweetener means
	Lots I, II, III[1]	Lot III[2]		4:1	6:1	
S-4	48.82	45.60	Sucrose	48.82	52.55	50.68
SD-4	47.40	44.40				
SF-4	47.02	44.60	Sucrose +			
F-4	45.30	42.45	Dextrose	47.40	51.47	49.43
S-6	52.55	49.25	Sucrose +			
SD-6	51.47	48.25	Frodex	47.02	50.93	48.98
SF-6	50.93	47.15	Frodex	45.30	46.77	46.03
F-6	46.77	43.00				
FC-9	55.83	49.10	Means	47.13	50.43	48.78
SC-9	——	53.95				
L.S.D. (0.05)	2.52	4.40	L.S.D. (0.05)			1.78
L.S.D. (0.01)	3.47	6.00				

[1] All figures are means of 6 determinations.
[2] All figures are means of 2 determinations.

After 6 months of storage, the Hunter "L" readings were significantly different due to lots, treatments, and sweeteners. The dominant wavelengths were significantly different due to lots and sweeteners, while the purity values were significantly different due to lots only (Tables 3, 4, 5).

Effects on vitamin C content of the frozen berries. No significant differences in vitamin C content were found due to treatments, sweeteners, or ratios used. The 3 lots of strawberries had initially different vitamin C contents, and the difference was almost the same after 6 months of storage with a slight decrease in all.

Effects of the wholeness of the strawberries in the preserves. Of 27 tests run for wholeness of fruit in the preserves, 26 showed significant and/or highly significant differences in the degree of wholeness of the berries. These were further analyzed according to the method of the least significant difference to show which preserves were ranked higher than the others, but the results obtained did not allow any conclusions regarding the effect of the treatments, sweeteners, or ratios on the wholeness factor.

Flavor evaluation of the preserves. Six of the 28 tests run for flavor acceptability showed significant differences. The results of the tests that showed significant differences are presented in Table 6. Treatment SC-9 received high rank in five of the tests.

In tests No. 12 and 28 in which the variation due to the treatments could be traced down to the treatment components, it was found that in both cases there was a highly significant difference due to the sweetener used and that the effects of both the ratio and the interaction between ratio and sweetener were not significant. Therefore, in tests 12 and 28, preserves made from berries mixed with sucrose prior to freezing were more acceptable to the taste panel than those made from berries mixed with Frodex.

Effects on Hunter color values of the preserves. Hunter "L"

TABLE 3

Effect of lot on color measurements[1] of the frozen strawberries after 3 months' and 6 months' storage at 0° F. (—17.7° C.)

Lot no.	After 3 months' storage			After 6 months' storage		
	Hunter "L"	Dominant wavelength mμ	% purity	Hunter "L"	Dominant wavelength mμ	% purity
I	20.85	610.11	68.90	20.86	611.69	69.73
II	17.21	613.92	65.01	19.17	614.79	60.94
III	19.80	609.08	67.69	20.74	609.86	67.28
L.S.D. (0.05)	0.94	1.16	1.58	0.45	2.56	2.28
L.S.D. (0.01)	1.30	1.60	N.S.D.	0.62	3.52	3.14

[1] All figures are means of 72 determinations.
N.S.D.—Not significantly different at this level.

TABLE 4

Effect of treatments on color measurements of the frozen strawberries after 3 months' and 6 months' storage at 0° F. (—17.7° C.)

Treatment	After 3 months' storage				After 6 months' storage	
	Lot I, II, III [1]		Lot III only [2]		Lot I, II, III [1]	Lot III only [2]
	Hunter "L"	D.W.L.[3] mμ	Hunter "L"	D.W.L.[3] mμ	Hunter "L"	Hunter "L"
S-4	18.52	612.71	18.74	610.44	20.09	20.00
SD-4	18.89	611.10	18.91	610.13	19.90	20.70
SF-4	19.38	610.96	19.15	609.25	19.87	20.61
F-4	20.77	608.29	21.94	606.38	21.23	21.63
S-6	18.08	613.33	18.59	610.50	19.65	20.44
SD-6	18.84	612.42	19.01	611.13	19.79	20.26
SF-6	19.46	610.90	21.00	608.75	20.40	20.43
F-6	20.57	608.79	20.76	607.60	21.59	22.03
FC-9	19.26	610.83	20.08	607.50	19.79	20.59
SC-9	.....	.....	18.33	610.75	.....	18.81
L.S.D. (0.05)	1.63	2.02	3.49	2.82	0.774	1.34
L.S.D. (0.01)	2.24	2.78	4.81	3.89	1.067	1.85

[1] All figures are means of 24 determinations.
[2] All figures are means of 8 determinations.
[3] Dominant Wavelength.

readings, dominant wavelengths and purity values of preserves made from strawberries stored for 3 months were not significantly affected by lots, treatments or sweeteners used prior to freezing.

In the preserves made after 6 months of storage there were highly significant differences in Hunter "L" readings, dominant wavelengths, and purity values due to lots (Table 7). There was a significant difference in the Hunter "L" readings due to sweeteners, with Frodex resulting in the highest reading at 10.65, and sucrose resulting in the lowest at 10.07. Ratios caused a significant difference in dominant wavelength.

Effects on A. M. S. scores for color of preserves. Results of A.M.S. visual grading indicated that the treatments used prior to freezing of the berries did not have any effect on the color score of the preserves. It is concluded that the color differences detected by the Hunter instrument, though statistically significant, were not commercially important. It is of interest to note that the significant color differences due to lots which were shown by the Hunter measurements were also detected by the A.M.S. inspector (Table 7).

Effects on vitamin C content of the preserves. Analysis of variance showed that the various treatments, sweeteners, or ratios used with the frozen berries stored for 6 months did not exert significant effects on the vitamin C content of preserves prepared from them. The only significant difference was due to lots; preserves made from lot I having higher vitamin C content than preserves made from lots II and III.

Effects on invert sugar in the preserves. Statistical analysis of sucrose: invert sugar ratios in the experimental preserves showed that they were highly significantly different due to lots, and sweeteners, and significantly different due to treatments. These results are reported in Table 8.

TABLE 5

Effect of sweeteners on color measurements[1] of the frozen strawberries after 3 months' and 6 months' storage at 0° F. (—17.7° C.)

Sweeteners	After 3 months' storage		After 6 months' storage	
	Hunter "L"	Dominant wavelength mμ	Hunter "L"	Dominant wavelength mμ
Sucrose	18.30	613.02	19.87	613.20
Sucrose: Dextrose	18.77	611.76	19.84	613.90
Sucrose: Frodex	19.42	610.93	20.14	611.96
Frodex	20.67	608.54	21.41	609.50
L.S.D. (0.05)	1.15	1.43	0.55	2.56
L.S.D. (0.01)	1.59	1.96	0.75	3.52

[1] All figures are means of 48 determinations.

DISCUSSION

Results of color evaluation of the frozen strawberries. In studying methods for presenting raspberry and strawberry samples to the Hunter Color and Color Difference Meter, Tinsley *(15)* concluded that in sliced strawberries, the A.M.S. score for color increased fairly regularly with the appropriate change in brightness up to a certain point. There was a tendency to rate samples higher with a higher "L" value, until a critical value was attained after which the rating fell off rapidly with increase in Hunter "L". The dominant wavelength of strawberries did not appear to be a critical factor, providing it fell within the average range. Table 9 reports some of Tinsley's *(15)* findings with regard to A.M.S. scores for color and Hunter "L" values.

In the present work, the use of Frodex exerted significant effects on the Hunter "L" readings of the frozen whole berries. It is apparent from Table 4 that after 3 months' storage, all the treatments resulted in the same "L" readings as the 4:1 sucrose pack, except the 4:1 and 6:1 Frodex packs (Table 4). After 6 months' storage both the 4:1 and the 6:1 Frodex treatments

TABLE 7

Means of Hunter "L" readings,[1] dominant wavelength,[1] purity,[1] and visual scores[2] of preserves made after 6 months' storage of the frozen strawberries

Lot no.	Hunter "L"	Dominant wavelength mμ	Purity %	Visual score
I	10.58	611.94	43.10	17.50
II	9.82	622.19	37.30	16.30
III	10.62	611.21	41.94	17.20
L.S.D. (0.05)	0.30	5.06	2.71	0.53
L.S.D. (0.01)	0.42	6.98	3.73	0.73

[1] All figures are means of 72 determinations.
[2] All figures are means of 36 determinations.

TABLE 6

Mean scores of certain flavor acceptability tests of the preserves in order of magnitude

Test No. 8[1]		Test No. 12[2]		Test No. 24[1]		Test No. 25[1]		Test No. 27[3]		Test No. 28[3]	
Sample	Mean score	Sample	Mean score	Sample	Mean score	Sample	Mean score	Sample	Mean score	Sample	Mean score
SF-6	+0.57	SC-9	+0.69	SC-9	+0.40	SC-9	+0.63	SC-9	+0.20	SC-9	+0.19
S-4	+0.24	S-6	+0.10	S-4	+0.16	SD-6	−0.11	FC-9	+0.09	S-6	+0.08
F-4	−0.13	FC-9	−0.34	S-6	−0.11	F-6	−0.11	F-6	+0.05	F-6	−0.06
FC-9	−0.21	F-6	−0.44	FC-9	−0.45	F-4	−0.40	S-6	−0.08	FC-9	−0.21
SD-6	−0.47	.....	.....	.....	.....	.....	.....	F-4	−0.26	.....	.....
L.S.D.*	0.61		0.53		0.59		0.56		0.19		0.25
L.S.D.**	0.82		0.70		0.79		0.75		0.26		0.33

[1] Panel size 12 judges.
[2] Panel size 127 judges.
[3] Panel size 70 judges.
* At the 0.05 level of probability.
** At the 0.01 level of probability.

TABLE 8

Effect of treatments,[1] sweeteners,[2] and lots[3] on sucrose/invert sugar ratios in the preserves prepared from frozen strawberries after 6 months of storage at 0° F. (—17.7° C.)

Treatment	Sucrose/invert sugar	Sweetener	Sucrose/invert sugar
S-4	1.57	S	1.69
SD-4	1.29	S-D	1.32
SF-4	1.71	S-F	1.57
F-4	1.18	F	1.33
S-6	1.82	L.S.D. (0.05)	0.23
SD-6	1.34	L.S.D. (0.01)	0.32
SF-6	1.44	Lot no.	Sucrose invert sugar
F-6	1.48	I	1.09
FC-9	1.32	II	1.61
		III	1.69
L.S.D. (0.05)	0.33	L.S.D. (0.05)	0.19
L.S.D. (0.01)	0.45	L.S.D. (0.01)	0.26

[1] All figures are means of 6 determinations.
[2] All figures are means of 12 determinations.
[3] All figures are means of 18 determinations.

resulted in higher readings than the 4 : 1 sucrose control.

According to Tinsley *(15)* the A.M.S. scores for these berries for consumer package-use would be depressed, since both sample lots had "L" readings above 20.5. This would indicate excessive lightness (Table 9).

These differences were detectable in the preserve samples which were made after 6 months' storage, with the use of Frodex resulting in the highest readings. However, as already noted, this did not affect the A.M.S. color score for the finished product.

These observations indicate that sweeteners can affect the color of strawberries and their products; but the commercial importance of the effect depends upon the range of color considered.

Results of invert sugar in the preserves. The results showed definitely that when Frodex was added to the frozen strawberries the invert sugar content was significantly higher in the preserves than when sucrose was the sweetener added. Substitution of 25% of the sucrose with Frodex did not result in a significant increase in invert sugar content of the preserves, while the same substitution with dextrose caused a significant increase in the invert sugar content. The degree of the inversion of the sucrose added to the fruit during the manufacture of preserves and afterwards during storage is related to the degree of sweetness of the preserves, and to their stability against crystallization. Bates and associates *(3)*, and Atkinson, Strachan, Moyls, and Kitson *(2)* are of the opinion that a jam or candied fruit having a total sugar content of 68 to 72% should have a ratio of sucrose to invert sugar maintained at 1 : 1 to 3 : 2 in order to prevent crystallization.

TABLE 9

A. M. S. color scores and Hunter "L" values of strawberries[1]

Samples	Hunter "L"	A.M.S. score
1	15.40	30
2	16.20	33
3	17.50	35
4	17.60	34
5	18.00	35
6	18.70	35
7	18.90	34
8	20.50	28
9	20.80	28
10	20.90	28
11	21.40	24

[1] After Tinsley *(15)*.

Bearing in mind that both Frodex and dextrose possess reducing power which was obviously responsible for an undetermined part of that increase in invert sugar values over those obtained when only sucrose was utilized, and considering that the low sucrose : invert sugar ratios are still within the recommended ratios *(2, 3)*, it is concluded that the different treatments used did not have any detrimental effect on the quality of the preserves. It is noteworthy that throughout this work crystallization has not been encountered in any of the samples up to 7 months of storage.

CONCLUSIONS

The drained weights of frozen strawberries were more influenced by the ratio than by the kind of sweetener added to the fruit prior to freezing. The 9 : 1 ratio resulted in the highest drained weights, and the 4 : 1 ratio resulted in the lowest. However, within a given ratio, sucrose resulted in significantly higher drained weights than Frodex, and the substitution of 25% of the sucrose with either Frodex or dextrose did not significantly lower the drained weight.

The appearance of the frozen berries was influenced by the method of mixing the sweetener with the berries rather than the sweetener itself. Capping resulted in berries with better appearance than in the case of hand-mixing regardless of the sweetener used. However, Frodex had a more deleterious effect than sucrose when both were hand-mixed with the fruit. This can be attributed to more disintegration of the berries when mixed with the coarser granules of Frodex.

Use of Frodex resulted in whole berries of lighter color than did the use of sucrose. This effect carried over into certain lots of the finished product.

Vitamin C contents of the frozen strawberries and preserves prepared from them, as well as the wholeness of the fruit in those preserves, were not significantly affected by the sweeteners added to the berries prior to freezing, the ratios in which they were used, or the method of their application.

There were indications that sucrose capped berries resulted in preserves with superior flavor to those prepared by other techniques and from other sweeteners.

Invert sugar contents of the preserves depended on the sweeteners and treatments used with the frozen berries. No conclusions could be reached, however, regarding the superiority of one sweetener over another in enhancing invert sugar production.

Acknowledgments

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The Peeling of Apples with Infra-red Radiation[a]

(Manuscript received April 13, 1956)

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Apples lose 15 to 18% of their weight when peeled by mechanical peeling machines *(2)*. The peel consists of the epidermis and hypodermis, known as the histological peel, and some flesh. Since the flesh is the most valuable portion of the apple to the processor, the removal of the histological peel only is desirable.

Flame peeling *(1)* and peeling by an electric furnace *(3)* have been used in an attempt to reduce peeling losses of apples. In both these peeling procedures, the outer layers of the apples become charred and subsequently lost by a combination of abrasion or brushing and washing under high water pressure.

Preliminary investigations carried out in this laboratory showed that a blistering of the apple occurred within 40-45 seconds when exposed in a muffle oven at 850° F. Subsequent cooling and removal of the peel resulted in a weight loss of only 3-4%. During this treatment the outer flesh of the apple was cooked to a depth of about 4 mm. Presumably, during exposure of the apple to the high temperature, some steam was formed in the intercellular spaces immediately below the histological peel. With the build-up of steam pressure, the intercellular connections in this region were severed, thus allowing the removal of the histological peel.

Investigations were conducted to determine the optimum temperature and exposure time for the peeling of apples with an infra-red heat source in an insulated tunnel.

EXPERIMENTAL

The varieties McIntosh, Cortland, R. I. Greening, Ottawa 2016 and Spiretta were stored at 34° F. for about one month before peeling. All apples were free from defects such as scab and insect injury, and were graded as Fancy.

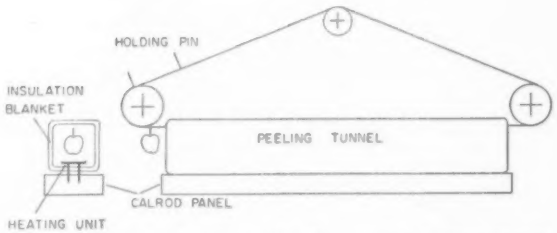

Figure 1. Plane and cross-section diagrams of peeling tunnel.

The peeling unit (Figure 1) consisted of a 6 ft. long infra-red radiant panel[b] enclosed by a half-inch thick insulation blanket of fibrous silica between two foils of inconel.[c] An endless belt, containing steel pins for carrying the apples through the tunnel was operated manually.

A definite temperature in the tunnel was obtained by using either 3000, 4000 or 5000 watt calrod units. Temperatures were measured with a Leeds-Northrop potentiometer using a chromel-alumel thermocouple located at the centre of the tunnel.

Each apple, at room temperature, was pushed onto a steel pin and carried through the tunnel at a slow rate of speed. As soon as blistering was complete the apple was removed and cooled immediately in cold water.

RESULTS AND DISCUSSION

The element and tunnel temperatures for the 3000, 4000 and 5000 watt calrod heating units are shown in Figure 2. The maximum temperature for each unit was reached within 10-15 minutes and remained constant throughout the experiment.

The difference between the element and tunnel temperatures for each unit did not exceed 150° F. The efficiency of the insulation was also demonstrated by the temperatures of 1500° F. and 250° F. for the inside and outside surfaces, respectively.

The data in Table 1 indicate that as the tunnel temperatures increased, the peeling time and thickness of the blanched layer decreased.

The tunnel temperature differences between the 3000 and 4000 watt elements and between the 4000 and

[a] Contribution No. 868 from the Horticulture Division, Experimental Farms Service.

[b] General Electric infra-red radiant calrod panel, type OX1AA.

[c] "Refrasil" insulation blanket, manufactured by H. I. Thompson Co. Ltd., Guelph, Ont.

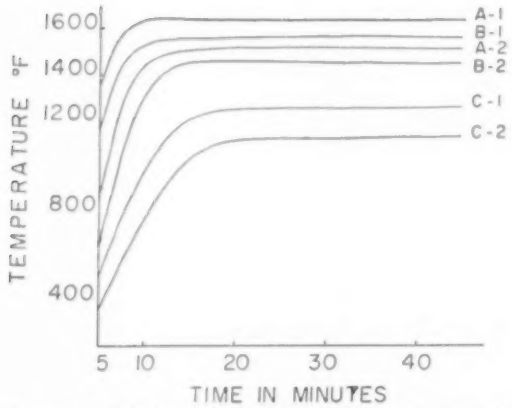

Figure 2. Relation between heating time and temperature of the heating elements (A-1, B-1, C-1) and the centre of the tunnel (A-2, B-2, C-2). A = 5000 watt, B = 4000 watt, C = 3000 watt.

5000 watt elements were about 250° F. and 50° F., respectively. However, the differences in peeling times were 13 seconds and 11 seconds.

During peeling the rate of heat absorption by the moisture in the intercellular tissue between the hypodermis and the cortex governed the peeling time. Heat transfer to this moisture at these high temperatures occurred by conduction and radiation, but radiation pre-

TABLE 1

Effect of tunnel temperatures on the peeling time and thickness of the blanched layer of McIntosh apples

Heat source	Temp. in centre of tunnel	Average peeling time[1]	Thickness of blanched layer
Watt	*degrees F*	*seconds*	*mm.*
3000	1220	39	2.3
4000	1470	26	1.2
5000	1520	15	less than 1

[1] Average for 24 apples.

sumably was more important. Figure 3 shows that when the temperature of a radiant source is increased, the wavelength distribution curve is shifted towards smaller wavelengths. As is seen in Figure 4, however, wavelengths below 1.4 micron are not completely absorbed by water, indicating that heat sources above 1600° F. would not be very efficient. According to Stefan's law, the energy content of heat sources decreases in proportion to the fourth power of their absolute temperatures, so that it appears that temperatures of around 1600° F. would be most desirable.

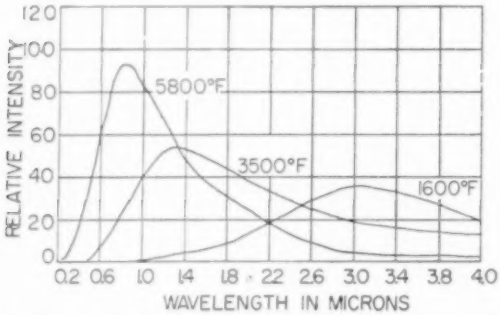

Figure 3. Relative intensities of various sources of infra-red radiation.

The results of peeling experiments at 1520° F. with five apple varieties, presented in Table 2, show large differences in required exposure time. The range of exposure time varied from 8-9 seconds for Spiretta, to 25-30 seconds for Cortland. The weight loss for each variety did not exceed 2.7%.

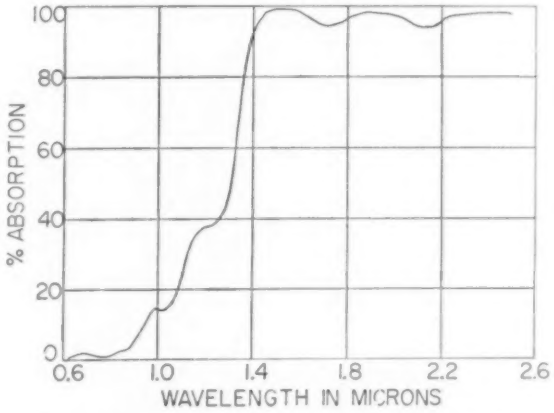

Figure 4. Absorption of infra-red radiation by water.

SUMMARY

Infra-red radiation can be used successfully for the peeling of apples. With a heat source of around 1520° F., exposure times of 9-30 seconds were required, depending upon the particular variety. Weight losses of the apples were about 2.5%.

TABLE 2

Approximate exposure times and weight losses for five apple varieties peeled at 1520° F.

Variety	McIntosh	Cortland	R. I. Greening	0-2016	Spiretta
Exposure time in seconds[1]	16-18	25-30	18-20	12-14	8-9
Weight loss (percent)	2.7	2.6	2.6	2.5	2.1

[1] Average of 15 apples.

With the present laboratory-size peeling tunnel, the commercial adaptability of the infra-red peeling could not be properly evaluated. The results obtained warrant further investigation on a commercial scale.

Acknowledgment

The co-operation of Mr. G. Remiz of the Canadian General Electric Co. Ltd., Toronto, Ontario, and of Mr. W. E. Ledigham of the H. I. Thompson Company, Guelph, Ontario, is gratefully acknowledged.

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Incorporation and Distribution of Monosodium Glutamate in Chicken Meat

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(Manuscript received February 20, 1956)

THE DISTRIBUTION of monosodium glutamate (MSG) obtained by several methods of incorporation are reported in this paper. Previously, scant data *(7)* have been available to poultry meat processors who wish to incorporate MSG into eviscerated poultry. The determination of optimum quantities of MSG for flavor enhancement also has been studied. The results of these studies will be reported later.

Three methods—liquid injection, a dip procedure, and a dusting procedure—were considered for incorporation of MSG into chicken meat. The "Hypospray" unit injects graded amounts, of up to one ml. (interstitially in the form of a high velocity jet), which penetrates the skin through a very small hole. Bauer *et al. (1)* reported that rapid distribution of liquids is obtained using this method in human subjects as compared to using a hypodermic needle.

In the dip procedure, fryer carcasses were cut up and dipped for varying lengths of time in an MSG solution. For the dusting method, weighed quantities of finely powdered MSG were sprinkled evenly over specific areas inside the cavity of freshly drawn birds.

The initial analyses for MSG were done by the microbiological method of Hac *et al. (5)*. To facilitate conducting large numbers of analyses, a specific decarboxylation method, based on a report by Roberts *(3)*, was adapted.

MSG distribution in various tissues was also determined by tracer techniques, utilizing DL-glutamic acid-2-C^{14}.

All chickens used in these experiments were New Hampshire or Indian River fryers, 10 weeks old, and 2½ to 2¾ pounds in weight. All birds were slaughtered by the Kosher method, scalded 0.8 minutes at 140° F., and then plucked on an automatic picker.

ANALYTICAL METHODS

Decarboxylation technique. Ten grams of muscle was disintegrated in a Waring blender with approximately 35 ml. 0.1N acetate buffer, pH 4.5, and made up to 50 ml. with the buffer. The mixture was centrifuged and the liquor filtered through glass wool. Two ml. of the extract was placed in a Warburg flask which contained a previously prepared suspension of 3 mg. of L-glutamic acid decarboxylase in 0.5 ml. of the acetate buffer in the side arm. The flask was attached to a manometer and placed in the Warburg apparatus at 28° C. After temperature equilibration, a reading was recorded, the decarboxylase mixed with the sample, and the reaction allowed to proceed with readings being taken after 30 and 40 minutes reaction times. Trial runs were made with different quantities of decarboxylase and that quantity producing maximum CO_2 in 30 minutes from 2 mg. MSG was used. Three mg. of the enzyme produced 96-102% recoveries. The addition of cocarboxylase was not necessary.

Isotopic technique. To determine the actual distribution of MSG obtained by the "Hypospray" injection method, one ml. of 35% MSG containing 0.8 μc. of DL-glutamic acid-2-C^{14} was injected into the fleshy part of the chicken. The chicken was then quick-frozen immediately or after aging (to allow for distribution), cut cross-wise against the tissue fibers into slices approximately 0.7 cm. thick, and lyophilized. Each slice was then placed on a grid, and subjected to count analysis using a Geiger unit. This procedure enabled counts per minute per 0.40 square centimeter of area to be obtained, thus permitting construction of "isoactivity" diagrams with data expressed as counts per minute per square centimeter (corrected for background count).

Similar treatment was accorded whole chicken breasts and legs dipped into 35% MSG solution containing 0.8 μc. of DL-glutamic acid-2-C^{14} per ml.

Radioautographs were prepared to show the distribution obtained by the dusting technique. The cavity areas adjacent to the thigh were dusted with 2 g. and the breast area with 4 g. of MSG containing 1.67 μc. of DL-glutamic acid-2-C^{14} per g. After storage and freezing, followed by cutting the breast and leg perpendicularly to the treated surface and lyophilizing, the slices were placed in contact with high speed film for 7 days and then developed.

EXPERIMENTAL DATA

"Hypospray" injection. It was considered that the best distribution with the "Hypospray" method would be obtained by injecting the live bird, whereby normal fluid movement in the body would aid in transferring the MSG throughout the flesh. However, experiments with "Hypospray" inoculation with 1 ml. of 35% MSG solution showed that this is not feasible. Numerous small blood vessels were ruptured, leaving a large "black and blue" area at the site of injection, thus giving the dressed chicken a very unsightly appearance.

Other experiments were made on eviscerated birds. Since diffusion of MSG would conceivably be more rapid in a warm than a cold bird, six fryers were injected immediately after bleeding, then dressed and eviscerated. The fryers were then cut up, broiled and subjected to organoleptic examination. The sites of injections gave the sensation of high glutamate concentration, and were considered quite unpalatable. Samples from which the sites of injection were cut out, could not be differentiated from the controls. These results suggested that little or no diffusion of MSG occurred, even after cooking.

In another trial, 1 ml. portions of 35% MSG solution were injected into each breast, leg, and thigh of a young frying chicken, immediately after being slaughtered, dressed, and eviscerated. It was then stored for one week at 40° F. to allow for further diffusion of the MSG. A control bird was similarly treated (except for MSG injection). Microbiological analyses revealed that even in this case, the glutamate remained largely at the site of injection; analyses showed 0.22% MSG for the injected muscle versus 0.08% for muscles from control birds as well as for muscles adjacent to injected areas.

In another experiment two drumsticks and two breasts from freshly dressed and eviscerated chickens were injected with MSG containing DL-glutamic acid-2-C^{14}. One each of the drumsticks and breasts were immediately quick-frozen; the other pieces were stored for one week at 35° F. before freezing. These samples were then treated as given under the isotopic technique; the resulting "isoactivity" diagrams are shown in Figures 1, 2 and 3. Due to experimental difficulties, reliable data on the stored drumstick samples were not obtained and these have been omitted from the figures.

Dip procedure. Early studies made on dipping cut-up, freshly dressed, warm fryers, in a 35% MSG solution at 50° F. for 10 minutes showed a significant increase in glutamate absorption. Data obtained by microbiological analyses of the total muscle tissue are presented as part of Table 1. Pre-chilled chickens were used in subsequent dipping experiments since this seemed to be most feasible for possible commercial application. Chilled, cut-up fryers were taken from the packaging line in a commer-

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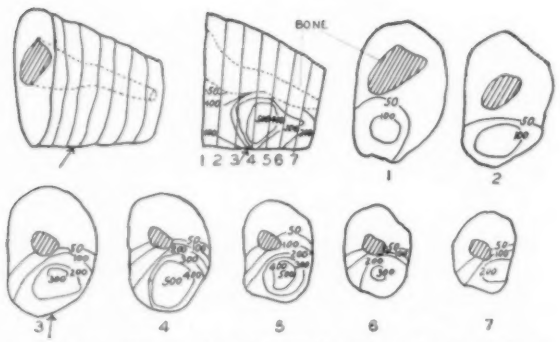

Figure 1. Distribution of MSG in chicken leg by "Hypospray" injection. (Analysis made immediately after injection.)
Illustration shows position of slices in injected leg.
Leg was injected with one ml. of 35% MSG solution containing 0.8 μc of dl-glutamic acid-2-C^{14}.
Data given in counts per min. per sq. cm. (0.4 times natural size).

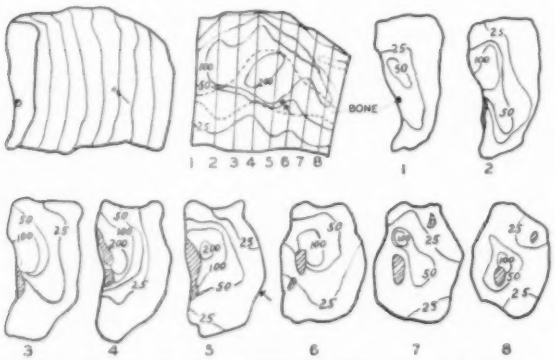

Figure 2. Distribution of MSG in chicken breast by "Hypospray" injection. (Analysis made immediately after injection.)
Injected with one ml. 35% MSG solution containing 0.8 μc of dl-glutamic acid-2-C^{14}.
Data given in counts per min. per sq. cm. (0.4 times natural size).

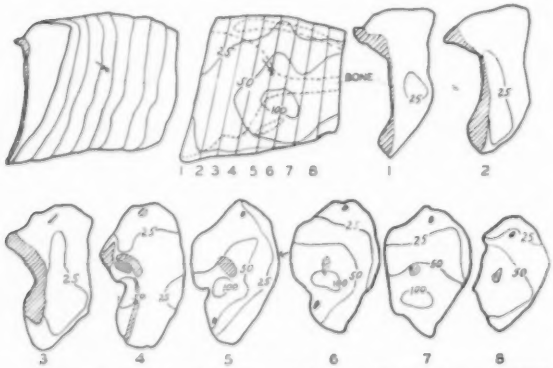

Figure 3. Effect of holding period on distribution of MSG after injection of chicken breast by "Hypospray." (Analysis made after holding sample one week at 35° F.)
Injected with one ml. 35% MSG solution containing 0.8 μc of dl-glutamic acid-2-C^{14}.
Data expressed as counts per min. per sq. cm. (0.4 times natural size).

cial plant and dipped for one minute in a 35% MSG solution at 65° F. These samples plus the controls were immediately frozen for subsequent treatment and analysis. The inner muscles

TABLE 1
Amount of MSG incorporated by dipping

Sample	Treatment[1]						
	A	B			C		
	Total edible portion (less skin)	Edible portion[2]			Edible portion[2]		
		Inner	Outer	Total	Inner	Outer	Total
	%	%	%	%	%	%	%
Breast	1.46	0.24	0.83	0.75	0.13	0.69	0.60
Thigh	2.29	0.26	0.75	0.63	0.13	0.42	0.32
Leg	0.95	0.04	0.37	0.23	0.10	0.25	0.19

[1] Treatments: Thigh and leg dipped as one piece.
A—Warm freshly dressed portions dipped in 35% MSG at 50° F. for 10 minutes.
B—Chilled freshly dressed portions dipped in 35% MSG at 65° F. for 1 minute.
C—Same as B, except samples cooked in deep fat before analysis.

[2] Edible portions — Approximate Percent of Total

	Breast	Thigh	Leg
Inner	20	25	40
Outer	80	75	60

and outer muscle layers with the skin were analyzed separately by the decarboxylation method. Two of the chickens were cooked in deep fat at 375° F. until golden brown. The results are given in Table I. In both the cooked and uncooked samples, the drumstick and thigh were dipped as one piece (i.e. they were not disjointed).

Radioactive glutamate was also used to determine the distribution of MSG using the dip procedure. In this case a freshly killed and plucked fryer was chilled to 35° F., then eviscerated and cut up into frying portions. Since the skin seemed to be an effective barrier to glutamate diffusion, the skin of the thigh was left on the drumstick and sealed so that none of the dipping solution came in direct contact with the cut end of the drumstick. Two drumsticks and two half breasts were dipped for 10 minutes in the C^{14} labeled glutamate solution at 35° F. One

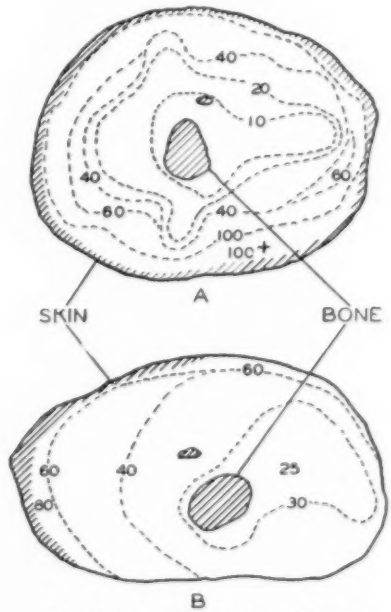

Figure 4. Distribution of MSG in chicken leg using dip procedure.
A. Cross-section from center of leg immediately after dipping.
B. Cross-section from center of leg stored one week at 35° F. after dipping.
Pieces dipped in 35% MSG solution containing 0.8 μc dl-glutamic acid-2-C^{14} per ml. Data expressed as counts per sq. cm. (Illustrations 0.7 times natural size.)

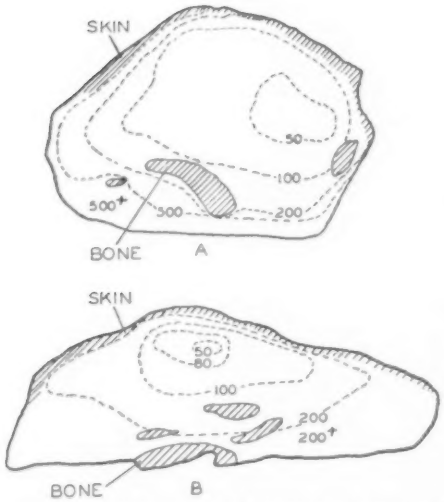

Figure 5. Distribution of MSG in chicken breast using dip procedure.

A. Cross-section from center of breast immediately after dipping.

B. Cross-section from center of breast stored one week at 35° F. after dipping.

Pieces dipped in 35% MSG solution containing 0.8 μc dl-glutamic acid-2-C[14] per ml. Data expressed as counts per sq. cm. (Illustrations 0.7 times natural size.)

drumstick and half breast were then frozen immediately while the remainder was stored 7 days at 35° F. before freezing. The samples were then prepared and counted with results shown in Figures 4 and 5.

Dusting procedure. Most of the dusting experiments were conducted by sprinkling 2 g. of finely powdered MSG over each area of the cavity adjacent to the things and 4 g. on the breast cavity. [These quantities approximated addition of 0.75% MSG which was found to be the level for a significant effect on chicken flavor *(4, 8)*.]

All analyses were made by the decarboxylation method. The birds were hard frozen when sampled by use of an electric meat saw. The breast and thighs were divided in slices parallel to the dusted sections of the body cavity as shown in Figure 6. The thin layers adjacent to the cavity and carrying the unabsorbed MSG were discarded in order that only MSG actually diffused into the flesh was measured. Untreated chickens were included in all experiments as controls. The results are the averages of two birds with duplicate subsamples.

The effects of storage at 35° F. for various lengths of time, thawing, and various lengths of frozen storage on the diffusion of glutamate were studied. The type of treatment, storage conditions and results are tabulated in Table 2.

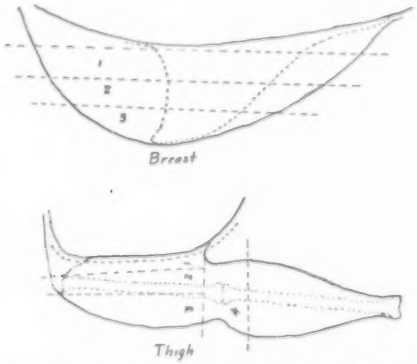

Figure 6. Location of analyzed samples in dusted chickens.

TABLE 2

Influence of sotrage conditions and thawing on distribution of MSG in dusted samples

Sample[3]		Storage conditions						Thawing conditions	
		Days						Hours	
		2	4	7	7[4]	30	104	24	36
		°F.						°F.	
		35°	35°	35°	35°	0°	0°	70°	45°
Breast	1	% 0.59	% 0.82	% 0.71	% 0.47	% 0.10	% 0.12	% 0.49	% 0.30
	2	0.28	0.56	0.67	0.44	0.09	0.02	0.29	0.19
	3	0.19	0.61	0.61	0.28	0.13	0.09	0.41	0.32
Thigh	1	0.97	0.58	1.03	0.50	0.16	0.30	0.97	0.89
	2	0.39	0.40	0.64	0.31	0.06	0.08	0.22	0.17
	3	0.24	0.22	0.40	0.18	0.07	0.07	0.32	0.17
Leg	4	0.17	0.11	0.15	0.11	0.04	0.10	0.20	0.09

[1] 4 g. MSG sprinkled on cavity area adjacent to breast.
2 g. MSG sprinkled on cavity area adjacent to thigh.
[2] ½ the above quantity of MSG used.
[3] Samples taken as shown in Figure 6.

Radioautographs were prepared from chickens dusted by the above technique with powdered MSG containing 3.33 μc. DL-glutamic acid-2-C[14] per gram of MSG. One chicken was allowed to remain at 35° F. for 7 days, then frozen, sampled, lyophilized and its radioautograph obtained. Another was frozen immediately after dusting, held 7 days at 0° F., thawed 24 hours at 45° F. and refrozen for radioautograph preparation. The results obtained with the thigh are similar, though with slightly less diffusion, to those obtained with the breast, Figure 7.

RESULTS AND DISCUSSION

Although the "isoactivity" diagrams (Figures 1, 2, and 3) of "jet" injected leg and breast samples show some immediate and latent distribution of MSG, several factors must be investigated before this method can be considered for commercial application. Small panel tests on fried chicken *(2)*, chicken patties *(8)*, and canned chicken *(4)* have shown that from 0.2 to 0.75% MSG is required to produce a significant effect. If we consider 0.5% MSG as the minimum necessary concentration, 6.5 ml. of 35% MSG would be required per pound of chicken flesh. Since high concentrations in any particular location must be avoided (because of unpalatability), injections would have to be in small portions and at numerous sites. Proper design of injection equipment may prove this method to be feasible.

Our preliminary experiments on dipping warm, cut-up fryers in 35% MSG solution at 50° F. for 10 minutes, have shown considerable incorporation. Table 1. Further experiments using pre-chilled birds were carried out, since this would seem to be more practical in a processing plant. These experiments, in which pre-chilled cut-up fryers were dipped in 35% MSG at 65° F. for one minute showed (Table 1) an appreciable incorporation of MSG. Although the inner edible portions showed a low concentration, this pattern of concentration may be satisfactory for the effect desired. Unreported taste panel work in our laboratory and work in other laboratories *(6)* show that MSG has what may be considered a "lingering" taste effect. That is, once the mouth has been "sensitized" by glutamate, the effect can be carried over to samples that have no glutamate. Thus a relatively high concentration on the

surface would give a "lingering" effect which might last through consumption of the remainder of the pieces. Further studies on this aspect of MSG need to be carried out.

Comparison of "isoactivity" diagrams (Figures 4 and 5) of samples dipped in 35% MSG solution containing DL-glutamic acid-2-C^{14} show latent diffusion of MSG during storage for 7 days at 35° F. The skin is a considerable barrier to MSG penetration. This can be seen by the higher counts obtained on the breast samples compared to those on the leg and also by noting the lower activity adjacent to the skin layer on the breast samples.

The dipping procedure, due to dangers involved of a contaminated dipping solution and wastefulness of an expensive ingredient, is not recommended and was studied solely to demonstrate the amount of MSG absorbed by this method. On the other hand it is possible that a quantity of MSG solution might be sprayed into the cavity of each bird or over boxes of cut-up fryers before the over-wrap is applied. Although no data are available on this procedure, the information obtained in the dusting procedure may be applied.

Due to the low penetration of MSG through chicken skin, the dusting experiments were carried out by sprinkling definite quantities of MSG on specific areas inside the cavity of drawn birds. From Table 2, it can be seen that the amount of MSG absorbed increased with time on storage at 35° F. Very little absorption took place during frozen storage even when stored for 104 days at 0° F. Absorption of MSG during thawing of birds frozen immediately after dusting was fairly rapid. The applicability of freezing birds immediately after treatment would depend on whether the consumer would thaw the birds slowly and cook them without washing.

Considering the anatomy of the bird, it is only necessary to apply the powdered MSG to the breast and thigh areas of the carcass cavity. Whn the amount of MSG dusted in the various areas was reduced by half, the quantity absorbed into the tissues was proportionally reduced (Table 2).

Radioautograms (Figure 7) of breast samples, dusted with 4 g. of MSG containing 13.3 μc. DL-glutamic acid-2-C^{14}, demonstrate visually the greater distribution obtained in holding samples 7 days at 35° F. after dusting over the immediate freezing and 24 hours thawing at 45° F.

SUMMARY

Methods of incorporating MSG into eviscerated poultry have been considered and partially evaluated.

It is suggested from the results obtained that satisfactory incorporation may be obtained by improved multiple jet injection, by spraying the cavity of freshly drawn birds with a concentrated MSG solution, or by dusting the cavity with finely powdered MSG.

Acknowledgment

This work was financially supported by the International Minerals and Chemical Corporation of Chicago. Credit for technical suggestions is due to Dr. B. F. Buchanan of the International Minerals and Chemicals Corporation.

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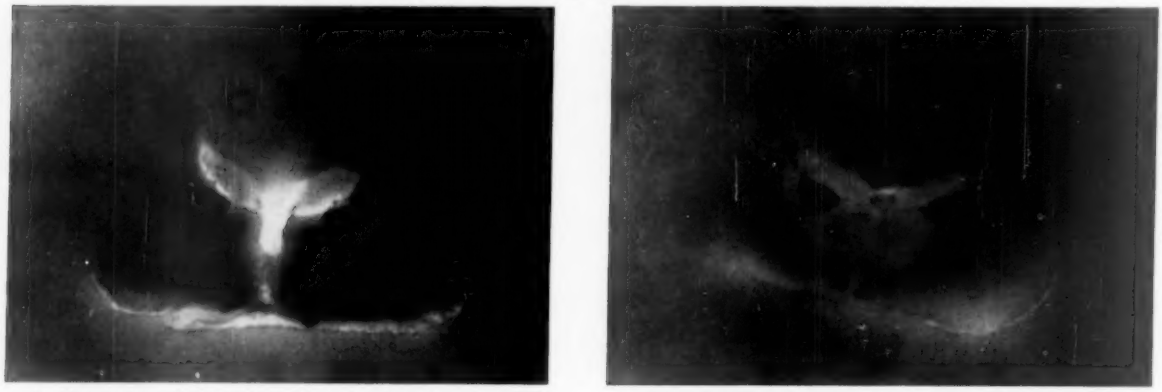
Figure 7. Cross-section radioautographs of C^{14} dusted chicken breast.



A. Frozen immediately after dusting, held 7 days at 0° F., thawed 24 hrs. at 45° F.

B. Stored 7 days at 35° F. after dusting.

Dusted on cavity side only with 4 gm. MSG containing 13.3 μc dl-glutamic acid-2-C^{14}.

Volatile Reducing Substances (VRS) And Volatile Nitrogen Compounds in Relation to Spoilage in Canned Fish*

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(Manuscript received March 9, 1956)

THE LITERATURE IS REPLETE with references to studies on methods of detecting spoilage in raw fish. Among these, determination of the amount of volatile nitrogen compounds occupies a prominent place and has been reviewed many times *(1, 2, 3, 4,* among others). Fewer studies have been reported dealing with spoilage in canned fish, particularly relating to the content of volatile nitrogen compounds *(5, 6, 7)*. Nevertheless, this is one of the methods often used to judge the condition of and to grade canned fish in many parts of the world.

Because exported canned California fish have at times been graded on the basis of their content of volatile nitrogen compounds, we became interested in studying the validity of this procedure and the relation of these compounds to the freshness of the canned product. Accordingly, starting a few years ago, all cans of fish submitted to this laboratory were examined for their content of total volatile (TVN) and trimethylamine nitrogen (TMN) so that these could be compared with that of volatile reducing substances (VRS). In this report are presented some representative data on the content of these substances in a number of species of fish, canned and varying in freshness or acceptability as human food, as judged organoleptically.

MATERIALS AND METHODS

Canned products. All the fish used had been commercially canned and became available during the course of the activities of this laboratory. They were evaluated organoleptically by means of the usual appropriate criteria, such as general appearance, color, texture, and in some cases odor, prior to the chemical examinations.

Sample preparation. The entire contents of a can was squeezed manually or mechanically in several thicknesses of cheesecloth or gauze, and the clear aqueous portion of the centrifugate used for the chemical determinations.

Volatile nitrogen compounds. The micro-diffusion procedure described by Conway *(8)* was used. One ml. of press juice was placed in the outer well of the Conway unit, and 1 ml. of 2% aqueous boric acid, containing 4% of an 0.1% alcohol solution of bromocresol green and 0.8% of an 0.1% alcohol solution of methyl red, was placed in the inner well. For the TVN determination 2 ml. of a saturated potassium carbonate solution was added to the press juice, whereas for the TMN determination 0.7 ml. of neutralized formalin was first added to the press juice and after mixing the solution alkalinized as above. After incubation at 37° C. for at least 1 hour or at room temperature for 2 hours the boric acid was titrated with approx. 0.03 N H_2SO_4 solution to the original indicator color. The values were expressed as mg. nitrogen per 100 ml. of press juice.

Volatile reducing substances. Until recently an apparatus previously described *(9)* was used, in which the laboratory air was purified by passage through alkaline permanganate before entering the press juice and a fresh supply of air was always aspirated through the sample by a vacuum pump. Recently this apparatus was redesigned to eliminate the air purification system and one of the two reaction flasks, and spherical 12/5 ball joints were used to replace the rubber or plastic tubing which connected the aeration and reaction flasks. A small recirculating pump needing no lubrication (such as a "Dyna-Pump," Redmond Company, Owosso, Michigan) was placed in series between reaction flask and the aeration flask. The pressure side of the pump was connected through a ball joint to the aeration flask, which in turn was connected through a ball joint to the air inlet tube of the reaction flask. The outlet of the reaction flask was connected through another ball joint to the suction side of the pump. In this manner the volume of air in the closed system (approximately 2 liters) could be repeatedly circulated for 40 minutes through the press juice sample and then through the alkaline permanganate reagent. The usual concentration used was 0.02 N $KMnO_4$ in N NaOH solution. Ordinarily an air blank was determined only periodically, since the reduction remains quite constant at a level of 2 to 4 microequivalents. (A single unit of the apparatus is shown in Figure 1.) For every determination, 10 ml. of the $KMnO_4$ reagent was pipetted into a reaction flask, and after the aeration period, 5 ml. of 6N H_2SO_4 and 3 ml. of a 20% KI in an 0.1% Na_2CO_3 solution were added. The liberated iodine was titrated with approx. 0.025N sodium thiosulfate in an 0.2% Na_2CO_3 — 0.1% $Na_2B_4O_7 \cdot 10\ H_2O$ solution, using 5 drops of 1% soluble starch in saturated NaCl solution as inside indicator. A control was always run with every determintion in which 10 ml. of the $KMnO_4$ solution in a reaction flask was left at room temperature for 40 minutes and then treated as the test reagent. The difference between the control and test titrations multiplied by 1000 times the normality of the thiosulfate solution yielded the amount of reduction by the test sample in microequivalents per 5 ml. of press juice.

Since the alkaline potassium permanganate solution is an extremely sensitive oxidizing reagent, it should be pointed out that extreme care in washing all the glassware is imperative. All traces of any fish oil or fish juice were removed in this laboratory by first rinsing the aeration flask with tap water to remove the canned fish juices, followed by a thorough scrubbing

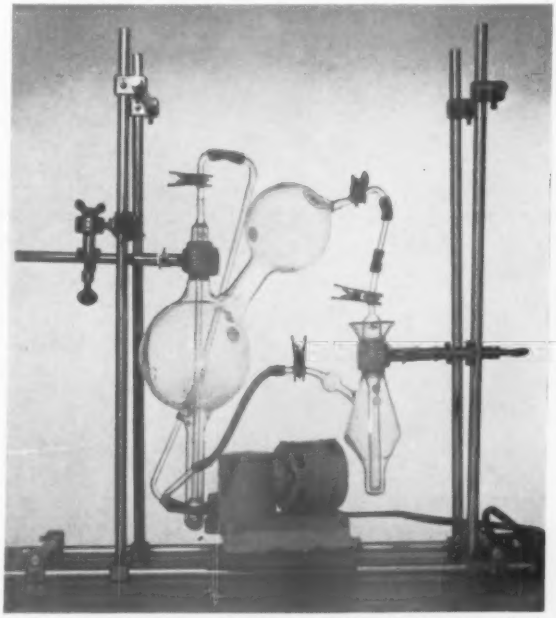

Figure 1. A single unit VRS apparatus, showing the spherical ball and socket joints and the recirculating pump.

* Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, June 13-16, 1955, at Columbus, Ohio.

with a hot detergent solution, a rinsing with tap water and finally repeated rinsing with distilled water. For raw fish juices the aeration flask was first rinsed with a dilute salt solution before being washed with the detergent.

EXPERIMENTAL RESULTS

In Table 1 are shown the ranges and average values for VRS, TVN and TMN in a number of representative cans of several species of fish packed in California or on the north Atlantic seaboard. The organoleptic grade was established on each can prior to the chemical determinations. Similar data for many more cans of the California fish are available and are continually being obtained. These data show that for all the species of fish studied, the content of VRS was quite closely correlated with the organoleptic judgment of the lots. In contrast, the total volatile nitrogen and the trimethylamine values in general did not reflect the results of organoleptic judgment.

DISCUSSION

As is to be expected in working with biological material, the results for cans of a single parcel or lot or batch varied somewhat. This variation is reflected in the VRS ranges given in the tables. The ranges for passable and not passable material overlap in some instances. This mainly results because, even though a particular batch or parcel of fish may be judged organoleptically to be not passable, not every can in the lot will show the same extent of spoilage, and some cans may not show any signs of deterioration. Yet, because most of the cans do show such signs, the lot is judged to be not passable. Conversely, passable batches are not always uniform, and a predominantly good one judged passable may still have a few cans which show some early changes or may even be considered of borderline passability. All of this is inherent in any system of grading based on organoleptic judgment. Because of the individual variability in a single lot of fish, at least six, and usually 12, cans are examined chemically. This yields an average value which ordinarily reflects the over-all organoleptic judgment. However, if variability should be greater than usual in the condition of the fish in a parcel of cans, one or more cases are then analyzed before any final conclusion is drawn regarding the condition of the lot. These instances of sampling difficulty ordinarily are not serious, and the cans of a particular parcel of fish are reasonably uniform. The uniformity is illustrated by the discreteness of most of the ranges.

In Table 1 it can be seen that for each species of fish the trimethylamine content, determined under the present conditions, seems to be distinct and to bear no definite relationship to the condition of the fish. More data are being collected, and further information should show whether the apparent species specificity of trimethylamine content in the canned material is a definite characteristic of such packs.

SUMMARY

The VRS appartus was changed to provide a closed system with a recirculating pump and spherical ball and joint connections.

The content of volatile reducing substances (VRS), total volatile and trimethylamine nitrogen (TVN, TMN) in canned California anchovies, California and Atlantic herring, California mackerel, California sardines in brine and in tomato sauce and tuna was determined for material judged orgnoleptically to be passable and not passable. The content of VRS correlated quite closely with the organoleptic judgment, whereas the content of TVN and TMN did not show any definite correlation. The content of trimethylamine nitrogen apparenly varies with the species of fish canned and is the same in fish of different states of freshness for any single species.

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TABLE 1
Contents of various substances in commercially canned fish

Sample	Organoleptic judgment	No. of cans	VRS [1]		Volatile nitrogen compounds			
					Total [2]		Trimethylamine [2]	
			Range	Average	Range	Average	Range	Average
California anchovies in tomato sauce	Passable	271	8.4–29.8	21.7	24.0–77.0	48.7	6.3–37.2	18.9
	Not passable	40	22.9–58.1	41.2	36.6–76.6	54.5	13.8–37.2	19.2
Pacific herring in tomato sauce	Passable	5	13.7–33.6	26.0	43.5–67.6	52.3	18.1–30.8	23.7
	Not passable	8	41.0–70.0	60.4	48.8–107.0	51.0	16.2–43.0	25.7
Atlantic herring in tomato sauce	Passable	44	14.4–39.3	29.0	56.2–105.0	78.0	26.5–66.0	44.0
	Not passable	17	41.2–55.0	45.8	59.2–140.0	88.4	24.0–68.0	44.7
California mackerel in brine	Passable	50	5.4–18.2	12.2	34.0–76.0	54.4	6.4–30.8	15.6
	Not passable	82	19.0–71.6	43.4	46.7–89.8	66.1	8.9–31.9	18.3
California sardines in brine	Passable	37	5.2–18.8	8.7	34.0–75.0	49.8	4.3–13.8	9.3
	Not passable	38	19.3–85.0	36.3	39.0–65.0	50.3	3.8–13.4	11.3
California sardines in tomato sauce	Passable	148	11.5–36.4	23.2	29.2–67.8	42.8	1.8–13.8	9.6
	Not passable	250	26.7–85.0	44.3	23.2–58.0	39.5	0–15.3	10.0
Tuna in oil	Passable	180	5.3–20.8	13.3	28.0–95.5	60.0	0–10.1	3.4
	Not passable	17	19.0–43.2	29.8	43.1–103.1	83.6	1.2–7.6	4.6

[1] Microequivalents reduction per 5 ml. of press juice.
[2] Milligrams nitrogen per 100 ml. of press juice.

Ionizing Radiations in the Processing of Plant and Animal Products[a]

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ALTHOUGH HEAT PROCESSING stabilizes food against deterioration due to bacterial action, chemical and physical changes may take place during and after heat processing which result in a considerable loss in quality. It would be desirable to have a method of destroying bacteria in food products which would not involve the application of heat and might result in less change in the product. In recent years *(2, 6, 7)* much attention has been focussed on ionizing radiations as a means of accomplishing this objective.

This paper is concerned with the effect on the organoleptic properties of certain food products of treatment with high voltage cathode rays. The prevention of radiation induced changes by irradiating under certain processing conditions is also included.

The following plant foods and food products were investigated: asparagus, broccoli, brussels sprouts, cauliflower, green beans, lima beans, peas, spinach, sweet potatoes, molasses, prunes, raisins and spaghetti.

Fishery products investigated included: fishcakes, halibut steaks and scallops.

EXPERIMENTAL

Irradiation technique. A Van de Graaff Accelerator *(8)* rated at 3 million electron volts was the source of the high voltage cathode rays used in these experiments. Samples to be irradiated were placed on a motor driven belt, the path of which traversed the electron beam.

Irradiation from both sides through the shortest dimension of the can was required for foods packed in sardine cans. These products were irradiated at voltages calculated to provide adequate penetration, the density and thickness of the food and the density and thickness of the container (sardine can) having been considered.

In the operation of the Van de Graaff Accelerator the dose rate was controlled by regulating the beam current and the speed of the belt that presented the sample to the beam. The applied dose was checked by using the ferrous-ferric system of dosimetry *(9)*. A run was considered satisfactory when the requested dose and the calculated dose did not differ by more than 10%.

Destruction doses. Experiments were carried out to determine the dose level of high voltage cathode rays necessary to provide commercial sterility in uninoculated vegetables.

These products were handled in a similar manner, including blanching, to that which might be used in vegetable canning and freezing plants. Commercial sterility, in this case, was considered to be the irradiation dose at which there was no significant increase in acrobic or anaerobic bacteria, as indicated by bacterial counts made at various dilutions on 3 samples representing each dose level, after incubating for 1 and 2 week periods at 37° C.

The approximate destruction dose was also determined for green beans, peas and sweet potatoes, inoculated with spores of *Clostridium sporogenes*. Heat processed comminuted foods were used as a source of product in this case. For each product 10 inoculated samples were irradiated at each dose level in increments of 0.5×10^6 rep.

The dose level for any product at which no growth occurred in any of the 10 samples, after culturing and incubating in suitable bacteriological media, was regarded as the destruction dose for the particular product.

In order to study the effect of different processing treatments prior to irradiation, some of the vegetable samples were: frozen after packaging; vacuum packed; vacuum packed and frozen; packed under nitrogen.

Organoleptic tests. Organoleptic tests were made immediately following the irradiation of vegetables treated at levels sufficient to provide commercial sterility. Samples were cooked in water and served while hot to a panel of tasters usually consistnig of 20 members. Evaluation of the product was by the hedonic scale method, in which a score of 9 indicated the most acceptable and a score of 1, the least acceptable product.

In preparing sweet potatoes for organoleptic tests the product was heated by immersing the sealed quarter-oil sardine cans, in which the product was packed, in boiling water for 10 minutes.

Halibut was prepared for tasting by pan frying in hydrogenated fat, whereas fishcakes were deep fat fried.

When taste tests were made on prunes, raisins, and molasses, no cooking or other preparations were used.

Storage tests. Sweet potatoes were packed in quarter-oil sardine cans and treated at irradiation dose levels sufficient to prevent bacterial spoilage. After irradiation they were stored at either 68° F. or 36-40° F. and tested, organoleptically, every 2 weeks over a period of 8 weeks.

Effect of irradiation on chemical changes. In order to determine the effect on radiation in causing chemical changes in foods subjected to this type of treatment, color (as chlorophyll) was determined for certain vegetable products *(3)*. Chlorophyll in green vegetables was extracted with acetone and the percentage of transmission through the spectrophotometer at a wavelength of 665 mμ was investigated. Ascorbic acid determinations were made on certain vegetables before and after cathode ray irradiation. Ascorbic acid content was determined by a modified colorimetric method *(5)*.

Effect of various processing methods on the destruction of Cl. sporogenes with high voltage cathode rays. Spinach which had been previously pureed and heat processed was chilled, inoculated with a heat-shocked spore suspension of *Cl. sporogenes* and blended in a Waring blender.

Fifteen-gram portions were placed in aluminum cups, 60 mm. in diameter and 15 mm. in height. These were scaled in sardine cans under the conditions of the processing method being investigated. Processing variables were as follows:

Packing in air and irradiation at a product temperature of 50° F.

Packing in air and irradiating in the frozen state.

Vacuum packing and irradiating at a product temperature of 50° F.

Packing under nitrogen and irradiating at a product temperature of 50° F.

Vacuum packing and irradiating in the frozen state.

In each case, 8 to 10 samples were irradiated at each of the following levels: 250,000 rep, 500,000 rep, and 750,000 rep. An equivalent number of non-irradiated controls were examined in each case.

The initial concentration of spores and the number of survivors of each irradiation dose were determined by direct count. This was done by culturing serial dilutions on Andersen's media (with bicarbonate solution) in 10 x 200 mm. tubes, stratifying with Vaseline and incubating at 37° C. *(1)*. Cultures were incubated for 3 days at 37° C. before colonies were counted.

A D_0 or 37% survival dose *(4)* was determined from the data

[a] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 617 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

obtained from each irradiated sample. The D_o values were calculated according to the equation:

$$n = n_o e^{-D/D_o}$$

Organoleptic tests were made on fishcakes, halibut steaks, and scallops, after irradiation treatment at the commercial sterility dose level previously determined.

Fishcakes were prepared by boiling 1 part of shredded fresh cod with 2 parts of peeled potatoes and then comminuting.

Both fresh and frozen halibut steaks were used, but when the frozen product was used it was thawed prior to irradiation treatment which was conducted at room temperature. Scallops were obtained in the frozen state and thawed before irradiation. All of these products were sealed in quarter-oil sardine cans prior to irradiation.

Miscellaneous foods. A number of miscellaneous food products were sealed in sardine cans and irradiated with high voltage cathode rays. These products were of the type which do not ordinarily undergo spoilage due to the growth of bacteria.

In some cases, irradiation was carried out at such levels as might be expected to destroy molds. In other cases, levels of about 100,00 rep were used which would destroy insects, insect eggs or metamorphic forms of insects. Organoleptic tests were made, after irradiating, on the food products selected; namely, molasses, prunes, raisins, and spaghetti.

RESULTS AND DISCUSSION

The results of bacterial counts on the different foods irradiated at various dose levels and incubated for 2 weeks at 37° C. are listed in Tables 1 and 2. The bacterial count methods were such that it was difficult to attain an absolute aseptic technique. It was therefore considered that the presence of *small numbers* of viable bacterial in cultures made from irradiated samples indicated contamination from the air, or other sources, introduced during the bacterial analysis, rather than organisms which had survived the irradiation treatment. The commercial sterilizing dose for any product was therefore regarded as that dose at which the bacterial count (aerobic and anaerobic) did not increase significantly over that obtained immeditely after irradiation, when the product had been incubated for 2 weeks at 37° C.

TABLE 1

Bacterial content of vegetables irradiated at several dose levels and held at 37° C. for 2 weeks

Irradiation dose and measurement		Storage at 37° C.		
		Initial	1 week	2 weeks
Asparagus				
Control	Standard Plate Count	42×10^6		
	Total Anaerobes	195×10^6		
	Putrefactive Anaerobes	3×10^6		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	10	792	19
	Putrefactive Anaerobes	2	49	3
Broccoli				
Control	Standard Plate Count	3.5×10^6		
	Total Anaerobes	136×10^6		
	Putrefactive Anaerobes	8.8×10^6		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	3	20	9
	Putrefactive Anaerobes	3	5	3
Green Beans				
Control	Standard Plate Count	753×10^6		
	Total Anaerobes	91.3×10^6		
	Putrefactive Anaerobes	62.6×10^6		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	1	6	2
	Putrefactive Anaerobes	0	0	1
Spinach				
Control	Standard Plate Count	425×10^6		
	Total Anaerobes	427×10^6		
	Putrefactive Anaerobes	27×10^6		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	88	37	101
	Putrefactive Anaerobes	3	7	9
Sweet Potatoes				
Control	Standard Plate Count	240×10^6		
	Total Anaerobes	88.7×10^6		
	Putrefactive Anaerobes	6×10^6		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	2	2	32
	Putrefactive Anaerobes	1	0	34

TABLE 2

Bacterial content of fishery products irradiated at several dose levels and held at 37° C. for 2 weeks

Irradiation dose and measurement		Storage at 37° C.		
		Initial	1 week	2 weeks
Codfish Cakes				
Control	Standard Plate Count	32×10^6		
	Total Anaerobes	18.5×10^6		
	Putrefactive Anaerobes	4300		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	21	73	145
	Putrefactive Anaerobes	4	6	22
Halibut Fillets				
Control	Standard Plate Count	75×10^6		
	Total Anaerobes	1.8×10^6		
	Putrefactive Anaerobes	271×10^3		
2×10^6 rep	Standard Plate Count	< 300	< 300	< 300
	Total Anaerobes	17	17	101
	Putrefactive Anaerobes	1	1	1
Scallops				
Control	Standard Plate Count	1.5×10^6		
	Total Anaerobes	45×10^3		
	Putrefactive Anaerobes	600		
1.5×10^6 rep	Standard Plate Count	< 300	< 300	TNTC
	Total Anaerobes	7	37	148
	Putrefactive Anaerobes	1	36	1

The sterilization dose determinations indicated only approximations, since dose increments of 500,000 rep were used in irradiating and the dose factor is dependent, among other factors, upon the initial number and types of bacteria present.

As determined by the method indicated, the commercial sterilizing doses for the various products are listed in Table 3. It can be seen that the dose required to prevent bacterial increases in samples incubated at 37° C. was in some cases 1.5×10^6 rep and with other products 2.0×10^6 rep.

TABLE 3

Dose of high-voltage cathode rays required to attain commercial sterility in various products

Dose	Product
1.5×10^6 rep	Asparagus Broccoli Codfish Cakes Green Beans Sweet Potatoes Spinach
2.0×10^6 rep	Halibut Scallops

The results of sterility tests with irradiated inoculated packs are reported in Table 4.

Green beans containing approximately 590 spores of *Cl. sporogenes* per gram were sterilized and showed no growth in 10 samples with a dose of 2.0 x 10^6 rep. Spinach containing approximately 160 spores per gram was also sterilized with a treatment of 2.0 x 10^6 rep.

TABLE 4

Number of samples[1] of vegetables showing growth after inoculation with Cl. sporogenes, irradiation and culture in thioglycollate broth

Sweet Potatoes				
Dose (rep)	1,800 spores per gram	1,800 spores per gram	46 spores per gram	20 spores per gram
None	10	10	10	10
1.0 x 10^6	5	2	5	6
1.5 x 10^6	2	1	1	0
2.0 x 10^6	0	0	0	0

Spinach				
Dose (rep)	163 spores per gram	100 spores per gram	21 spores per gram	
None	10	10	10	
1.0 x 10^6	8	1	1	
1.5 x 10^6	1	0	0	
2.0 x 10^6	0	0	0	

Green Beans				
Dose (rep)	590 spores per gram	510 spores per gram	290 spores per gram	10 spores per gram
None	10	10	10	10
1.0 x 10^6	2	4	10	6
1.5 x 10^6	1	0	2	0
2.0 x 10^6	0	0	0	0

Peas				
Dose (rep)		303 spores per gram	21 spores per gram	
None		10	10	
1.0 x 10^6		2	1	
1.5 x 10^6		0	0	
2.0 x 10^6		0	0	

[1] A total of 10 samples per dose level was studied.

Pea purée containing approximately 300 spores per gram was sterilized with a treatment of 1.5 x 10^6 whereas sweet potatoes containing 1,800 spores of *Cl. sporogenes* per gram were sterilized with a dose of 2.0 x 10^6 rep.

The D_0 values for *Cl. sporogenes* suspended in spinach and irradiated under different processing conditions are listed in Table 5. Vacuum packing, freezing, packing in a nitrogen atmosphere or a combination of vacuum packing and freezing significantly affected the D_0 value compared with the air-packed samples.

Part of this experiment was repeated using a freshly harvested crop of *Cl. sporogenes* spores. In this case, air-packed samples (50° F.) were compared with air-packed frozen samples. The results confirmed the previous findings indicating that the spores of *Cl. sporogenes* were more radio resistant in the frozen than the non-frozen state.

The mean D_0 values obtained in the repeated tests fell within the confidence limits of the mean D_0 value for the corresponding dose, for samples treated in the same manner, in the original experiment. This indicated that, in cases where the checks were made, the second test confirmed the results of the first test.

Over the dose range investigated, the survival curves for a given treatment were not straight but slightly curved lines (concave down). The D_0 value is sometimes expressed as the reciprocal of the slope of the survival curve wherein n/n_0 is plotted against dose in rep. That the D_0 values obtained for a given process at different dose levels were not of the same order may be explained by the fact that the survival curves were not straight lines but were curved with a constantly changed slope.

I. ORGANOLEPTIC EVALUATION OF FOODS IRRADIATED UNDER VARIOUS PROCESSING CONDITIONS

A. Vegetables

1. Asparagus. In 5 different flavor tests with asparagus which had been irradiated under normal conditions (that is, packed in air at room temperature) with a dose of 2.0 x 10^6 rep, 2 tests indicated that there was no significant difference in flavor between irradiated and non-irradiated samples and 3 tests indicated that a significant difference had occurred (Table 6). This implied that samples irradiated at the commercial sterility level (2.0 x 10^6 rep) are significantly different from non-irradiated controls. This difference was not obviated when the radiation treated products were: vacuum packed; frozen; vacuum packed and frozen; or packed in an atmosphere of nitrogen.

2. Broccoli. In 7 separate flavor tests on broccoli irradiated under ordinary conditions with a dose of 2 x 10^6 rep, 4 tests indicated that irradiated samples were significantly different from the non-irradiated samples and 3 of the tests indicated that the irradiated samples were not significantly different from controls (Table 7). The overall indication appeared to be that there is a significant difference between broccoli irradiated at room temperature and non-irradiated broccoli.

When samples were irradiated in the frozen state at a level of 2 x 10^6 rep no significant flavor change was apparent. Prevention of flavor change due to irradiation treatment could not be achieved by vacuum packing or by packing in an atmosphre of nitrogen.

3. Brussels Sprouts. The results of a single test with

TABLE 5

Calculated D_0 values for Cl. sporogenes suspended in spinach and irradiated under various conditions

Number of samples	Irradiation condition	Dose (rep)	Calculated mean D_0 value	Confidence limits at 95% level	Significance
6	Air atmosphere, 50° F.	500,000	187,000	±34,000	.....
12	Vacuum packed, 50° F.	500,000	257,000	±33,000	Significant
12	Air atmosphere, frozen	500,000	275,000	±30,000	Significant
10	N atmosphere, 50° F.	500,000	336,000	±26,000	Significant
10	Vacuum packed, frozen	500,000	411,000	±59,000	Significant
6	Air atmosphere, 50° F.	750,000	139,000	±12,000	.....
12	Vacuum packed, 50° F.	750,000	171,000	±10,000	Significant
12	Air atmosphere, frozen	750,000	192,000	±20,000	Significant
10	N atmosphere, 50° F.	750,000	250,000	±17,000	Significant
10	Vacuum packed, frozen	750,000	296,000	±32,000	Significant

TABLE 6
Organoleptic evaluation of irradiated and non-irradiated asparagus

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
None	None	5.58	.....	.....
None	2×10^6	4.79	Not significant	1.25
None	None	5.90	.....	.....
Frozen	None	5.63	Not significant	0.53
Frozen	2×10^6	2.63	Significant	6.09
None	None	5.50	.....	.....
Vacuum packed	None	5.20	Not significant	0.52
Vacuum packed	2×10^6	4.50	Not significant	1.76
None	None	5.53	.....	.....
None	2×10^6	3.63	Significant	3.34
Vacuum packed	2×10^6	3.32	Significant	3.32
N atmosphere	2×10^6	3.47	Significant	3.90
None	None	6.00	.....	.....
N atmosphere	None	6.00	Not significant	0
N atmosphere	2×10^6	3.40	Significant	3.71
None	None	5.63	.....	.....
Vacuum packed and frozen	None	4.32	Not significant	1.90
Vacuum packed and frozen	2×10^6	3.79	Significant	2.52
None	None	5.50	.....	.....
None	2×10^6	4.10	Significant	2.26
Treated with sodium ascorbate	2×10^6	5.50	Not significant	0
None	None	4.44	.....	.....
None	2×10^6	5.13	Not significant	1.11
Treated with mono-sodium glutamate	2×10^6	4.13	Not significant	0.43
None	None	6.00	.....	.....
Vacuum packed	None	5.90	Not significant	0.20
Vacuum packed	2.5×10^6	2.65	Significant	6.59
None	None	5.63	.....	.....
Vacuum packed and frozen	None	5.10	Not significant	1.06
Vacuum packed and frozen	2.5×10^6	3.00	Significant	4.46
None	None	6.63	.....	.....
N atmosphere	None	6.32	Not significant	0.83
N atmosphere	2.5×10^6	2.94	Significant	6.59
None	None	6.90	.....	.....
None	2.5×10^6	4.65	Significant	4.50
Treated with sodium ascorbate	2.5×10^6	3.70	Significant	6.67

Brussels sprouts indicated that air-packed samples irradiated at room temperature at a level of 2.0×10^6 rep were not significantly different from non-irradiated controls (Table 11).

4. Cauliflower. All samples of cauliflower irradiated under ordinary conditions at levels of 2.0 to 2.5×10^6 rep were found to be significantly different from the un-irradiated controls. The irradiation flavor is not obviated by vacuum packing or by freezing (Table 11).

5. Green Beans. In 9 separate flavor tests on air-packed samples of green beans irradiated at room temperature with a dose of 2×10^6 rep, irradiated samples were found to be significantly different from controls in two of the tests and not significantly different from controls in seven of the tests (Table 8). The results indicated that, under ordinary conditions, irradiation of green beans at levels of 2×10^6 rep does not result in a product which is significantly different in flavor from controls.

Irradiating (a) under vacuum, (b) while frozen, (c) in a nitrogen atmosphere, or (d) combinations of these, did not appear to result in a decided improvement in flavor over the irradiated sample which was not treated by one of these methods.

TABLE 7
Organoleptic evaluation of irradiated and non-irradiated broccoli

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
None	None	5.55	.....	.....
None	2×10^6	4.60	Not significant	1.58
None	None	5.50	.....	.....
None	2×10^6	4.00	Significant	3.06
Vacuum packed	2×10^6	3.65	Significant	3.94
None	None	5.50	.....	.....
None	2×10^6	4.70	Not significant	1.36
N atmosphere	2×10^6	4.95	Not significant	0.86
None	None	5.90	.....	.....
None	2×10^6	4.20	Significant	3.54
Frozen	2×10^6	5.25	Not significant	1.55
None	None	5.65	.....	.....
None	2×10^6	4.75	Not significant	1.95
Frozen	2×10^6	6.10	Not significant	0.98
N atmosphere	2×10^6	4.55	Significant	2.29
None	None	6.90	.....	.....
None	2×10^6	4.90	Significant	3.85
Vacuum packed	2×10^6	4.95	Significant	3.42
N atmosphere	2×10^6	4.40	Significant	5.11
None	None	6.35	.....	.....
None	2.5×10^6	4.05	Significant	4.89
None	None	5.50	.....	.....
None	2.5×10^6	3.35	Significant	4.57
Vacuum packed	2.5×10^6	3.90	Significant	3.02
None	None	6.05	.....	.....
None	2.5×10^6	3.50	Significant	6.07
Frozen	2.5×10^6	3.85	Significant	5.37

6. Lima Beans. Significant flavor changes, compared to controls, resulted in air-packed samples of lima beans

TABLE 8
Organoleptic evaluation of irradiated and non-irradiated green beans

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
None	None	5.15	.....	.....
None	2×10^6	4.35	Not significant	1.40
Frozen	2×10^6	4.60	Not significant	0.89
None	None	5.50	.....	.....
None	2×10^6	4.00	Significant	2.84
Frozen	2×10^6	4.50	Significant	2.18
None	None	5.70	.....	.....
None	2×10^6	4.40	Significant	2.96
Frozen	2×10^6	4.75	Significant	2.32
None	None	5.65	.....	.....
None	2×10^6	4.50	Not significant	1.91
Vacuum packed	2×10^6	4.60	Not significant	1.72
None	None	4.95	.....	.....
None	2×10^6	4.40	Not significant	1.02
Vacuum packed	2×10^6	3.70	Significant	2.19
None	None	5.20	.....	.....
None	2×10^6	4.30	Not significant	1.45
Vacuum packed and frozen	2×10^6	5.25	Not significant	0.08
None	None	5.11	.....	.....
None	2×10^6	4.33	Not significant	1.20
N atmosphere	2×10^6	4.66	Not significant	0.76
None	None	6.10	.....	.....
None	2.5×10^6	4.10	Significant	4.45
Vacuum packed	2.5×10^6	3.90	Significant	5.24
Frozen	2.5×10^6	2.80	Significant	7.96

TABLE 9
Organoleptic evaluation of irradiated and non-irradiated lima beans

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
None	None	5.70	.....	.....
None	2×10^6	5.20	Not significant	0.93
Vacuum packed	2×10^6	4.85	Not significant	1.44
None	None	5.50	.....	.....
None	2×10^6	4.20	Significant	2.36
Frozen	2×10^6	3.70	Significant	3.16
None	None	6.60	.....	.....
None	2×10^6	4.75	Significant	3.49
N atmosphere	2×10^6	3.95	Significant	4.65
Frozen	2×10^6	4.70	Significant	3.40
None	None	5.90	.....	.....
None	2×10^6	4.00	Significant	4.04
Vacuum packed	2×10^6	4.00	Significant	3.66
N atmosphere	2×10^6	3.90	Significant	4.16

irradiated, at room temperature, with a dose of 2×10^6 rep (Table 9). Neither vacuum packing, packing in a nitrogen atmosphere nor irradiating in the frozen state were effective methods of preventing flavor change due to irradiation treatment.

7. Spinach. The flavor panel results obtained with irradiated spinach (2.0×10^6 rep, air packed, room temperature) showed no significant flavor differences between control and irradiated samples (Table 10).

The flavor of irradiated samples was not improved

TABLE 10
Organoleptic evaluation of irradiated and non-irradiated spinach

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
None	None	5.86	.....	.....
None	2×10^6	4.53	Not significant	1.38
None	2.5×10^6	5.86	Not significant	0
None	None	5.76	.....	.....
Frozen	None	6.76	Not significant	1.44
Frozen	2×10^6	5.05	Not significant	1.14
None	None	4.40	.....	.....
None	2×10^6	5.40	Not significant	1.75
Frozen	2×10^6	4.85	Not significant	0.79
None	None	5.90	.....	.....
None	2×10^6	5.25	Not significant	1.41
Vacuum packed	2×10^6	4.65	Significant	2.32
None	None	6.15	.....	.....
None	2×10^6	3.35	Significant	5.84
Vacuum packed	2×10^6	3.50	Significant	5.31
None	None	6.20	.....	.....
None	2×10^6	3.55	Significant	5.30
Vacuum packed and frozen	2×10^6	5.10	Significant	2.30
None	None	6.25	.....	.....
None	2×10^6	4.90	Significant	2.70
N atmosphere	2×10^6	4.65	Significant	3.64
None	None	5.55	.....	.....
None	2.5×10^6	5.60	Not significant	0.10
Frozen	2.5×10^6	4.50	Not significant	1.88
None	None	6.68	.....	.....
Frozen	2.5×10^6	3.89	Significant	4.50
None	None	5.08	.....	.....
Vacuum packed	None	5.58	Not significant	0.80
Vacuum packed	2.5×10^6	3.25	Significant	2.92
None	None	6.47	.....	.....
None	2.5×10^6	4.29	Significant	3.88
N atmosphere	2.5×10^6	4.70	Significant	3.47

to any extent by irradiating as the frozen, vacuum packed or nitrogen packed product.

8. Sweet Potatoes. No significant flavor changes developed in air-packed samples of sweet potatoes irradiated at room temperature with dose levels as high as 2.5×10^6 rep (Table 11).

TABLE 11
Organoleptic evaluation of irradiated and non-irradiated sweet potatoes, brussels sprouts and cauliflower

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
Sweet Potatoes				
None	None	5.85	.....	.....
None	2×10^6	6.05	Not significant	0.43
Vacuum packed	2×10^6	6.15	Not significant	0.77
None	None	5.80	.....	.....
None	2.5×10^6	5.05	Not significant	1.34
Vacuum packed	2.5×10^6	5.10	Not significant	1.20
Brussels Sprouts				
None	None	5.15	.....	.....
None	2×10^6	5.25	Not significant	0.21
Cauliflower				
None	None	6.90	.....	.....
None	2×10^6	4.68	Significant	4.27
Vacuum packed	2×10^6	4.37	Significant	5.50
None	None	6.37	.....	.....
None	2×10^6	4.68	Significant	2.86
Frozen	2×10^6	4.63	Significant	2.90
Frozen	2.5×10^6	4.68	Significant	3.25
None	None	5.53	.....	.....
None	2.5×10^6	4.63	Significant	1.58
Vacuum packed	2.5×10^6	4.26	Significant	2.10

B. Fishery Products

1. Cod Fishcakes. The results of two taste tests indicate that as far as cod fishcakes were concerned there was no significant difference between the flavor of control samples or samples which had been irradiated at a level of 2.0×10^6 rep under one of the following conditions: air-packed at room temperature, vacuum-packed or frozen. Of the irradiated samples, those that were vacuum packed received the highest score (Table 12).

2. Halibut. When frozen halibut was thawed and then irradiated with a dose of 2.0 or 2.5×10^6 rep a significant flavor difference was found between irradiated and non-irradiated samples (Table 12). When fresh halibut steaks were irradiated with a dose of 2.5×10^6 rep no significant flavor difference was noted between treated and untreated samples.

C. Miscellaneous Food Products

1. Prunes and Raisins. It was found that either dried prunes or raisins could be subjected to an irradiation dose of 1.0×10^6 rep without developing flavor changes which were significantly different from untreated controls (Table 13). Since it is expected that insects and molds would have been destroyed at this level of irradiation treatment, higher dose levels were not investigated for these products.

2. Molasses. Molasses treated with a dose of 2.0×10^6 rep was scored considerably lower, but was not found to be significantly different in flavor from control samples (Table 13). This level of irradiation treatment would be sufficient to destroy eggs and the various metamorphic forms of insects.

TABLE 12
Organoleptic evaluation of irradiated and non-irradiated codfish cakes and halibut fillets

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
Codfish Cakes				
None	None	6.06	.....	.....
None	2×10^6	4.73	Not significant	1.77
Vacuum packed	2×10^6	5.40	Not significant	0.93
None	None	6.44	.....	.....
Vacuum packed	2×10^6	6.16	Not significant	0.51
Frozen	2×10^6	5.55	Not significant	1.85
Halibut Fillets				
None[1]	None	6.00	.....	.....
None[1]	2×10^6	4.79	Significant	2.09
None[1]	None	5.88	.....	.....
None[1]	2.5×10^6	3.83	Significant	4.02
None	None	6.05	.....	.....
None	2.5×10^6	5.88	Not significant	0.34
Packed in 1% brine	2.5×10^6	5.66	Not significant	0.98

[1] Prepared from frozen samples that were defrosted prior to irradiation.

II. STORAGE TESTS

Air packed samples of sweet potatoes irradiated at room temperature with a dose of 2.0×10^6 rep and then stored at 36 to 40° F. or at 68° F. were not significantly different in flavor from frozen controls during a period of 8 weeks' storage. Heat processed pureed sweet potato samples stored at 68° F. with irradiated samples were consistently rated lower than the irradiated samples (Table 14).

III. CHEMICAL CHANGES

The results of the effect of high voltage cathode ray treatment on the ascorbic acid content of vegetables are listed in Table 15. These findings did not confirm the conception that freezing or vacuum packing might lessen the destruction of ascorbic acid by radiation. In asparagus, having a natural ascorbic acid content of 10 mg. per 100 g., irradiation with a dose of 2×10^6 rep caused a 94% destruction of this compound (not reported in the tables). When this natural concentration was supplemented by treatment with sodium ascorbate to bring the concentration of 76 mg. per 100 g., the destruction of ascorbic acid due to irradiation at 2×10^6 rep was 71.5% (Table 15).

There was a noticeable loss in the chlorophyll content of asparagus and green beans, but only a slight loss in the chlorophyll content of broccoli and spinach, irradiated at a level of 2.0×10^6 rep. Vacuum packing effectively prevented the loss of chlorophyll due to irradiation treatment in asparagus, broccoli and spinach. However, samples irradiated in the frozen state had the best color and highest chlorophyll content (Table 16).

TABLE 13
Organoleptic evaluation of irradiated and non-irradiated molasses, spaghetti, prunes and raisins

Product treatment	Dose (rep)	Mean flavor score	Significance at 5% level	t value
Molasses				
None	None	6.80	.....	.....
None	2×10^6	5.90	Not significant	1.96
Spaghetti				
None	None	4.85	.....	.....
None	0.1×10^6	5.20	Not significant	0.69
Prunes				
None	None	6.50	.....	.....
None	0.50×10^6	5.75	Not significant	1.79
Vacuum packed	0.50×10^6	6.00	Not significant	1.25
None	None	6.35	.....	.....
None	1×10^6	5.95	Not significant	0.82
Vacuum packed	1×10^6	5.80	Not significant	1.10
Raisins				
None	None	6.75	.....	.....
None	0.50×10^6	7.00	Not significant	0.78
Vacuum packed	0.50×10^6	6.70	Not significant	0.11
None	None	6.65	.....	.....
None	1×10^6	6.85	Not significant	0.54
Vacuum packed	1×10^6	6.60	Not significant	0.11

CONCLUSIONS

'Commercial' sterilizing doses for certain vegetables, fishery, and miscellaneous food products were found to lie in the range of 1.5×10^6 rep to 2.0×10^6 rep.

D_0 values obtained for *Cl. sporogenes* suspended in pureed spinach and irradiated under different process-

TABLE 14
Organoleptic evaluation of irradiated and non-irradiated sweet potatoes held at various storage temperatures

Weeks in storage	Dose (rep)	Storage temp.	Mean flavor score	Significance at 5% level	t value
0	None	Room temp.	5.40	.....	.....
0	2×10^6	Room temp.	5.50	Not significant	0.19
2	None	0° F.	5.63	.....	.....
2	2×10^6	36-40° F.	4.79	Not significant	1.47
2	2×10^6	Room temp.	4.89	Not significant	1.30
2	Heat processed	Room temp.	4.26	Significant	2.21
4	None	0° F.	5.78	.....	.....
4	2×10^6	Room temp.	6.05	Not significant	0.47
4	Heat processed	Room temp.	4.16	Significant	2.64
6	None	0° F.	5.65	.....	.....
6	2×10^6	36-40° F.	5.20	Not significant	0.82
6	2×10^6	Room temp.	4.90	Not significant	1.41
6	Heat processed	Room temp.	4.75	Not significant	1.45
8	None	0° F.	5.80	.....	.....
8	2×10^6	36-40° F.	5.25	Not significant	0.94
8	2×10^6	Room temp.	5.35	Not significant	0.96
8	Heat processed	Room temp.	4.70	Significant	2.16

TABLE 15
Destruction of ascorbic acid in various vegetables by irradiation with high-voltage cathode rays (2×10^6 rep)

Food	Treatment	Ascorbic acid	
		mg./100 g.	Percent loss
Asparagus	Control	76.1	.....
	Irradiated	21.8	71.5
Broccoli	Control	18.1	.....
	Irradiated	2.5	86.5
	Frozen and irrad.	6.0	67.0
	Vacuum packed and irrad.	1.8	90.0
Green beans	Control	8.9	.....
	Irradiated	0.7	92.1
	Frozen and irrad.	0.7	92.1
	Vacuum packed and irrad.	0.8	91.0
Spinach	Control	6.2	.....
	Irradiated	2.2	64.5
	Frozen and irrad.	0.4	93.5
	Vacuum packed and irrad.	1.2	80.6

TABLE 16
Effect of high-voltage cathode rays (2×10^6 rep) on color (measured as chlorophyll) of various vegetables

Food	Treatment	Chlorophyll	
		p.p.m.	Percent loss
Asparagus	Control	76.0	.....
	Irradiated	64.0	15.7
	Vacuum packed and irrad.	75.0	1.2
	Frozen and irrad.	78.0	0
Broccoli	Control	70.5	.....
	Irradiated	66.2	6.0
	Vacuum packed and irrad.	69.0	2.0
	Frozen and irrad.	88.3	0
Green beans	Control	31.5	.....
	Irradiated	28.0	11.0
	Vacuum packed and irrad.	27.8	11.8
	Frozen and irrad.	38.0	0
Spinach	Control	190	.....
	Irradiated	179.5	5.5
	Vacuum packed and irrad.	190	0
	Frozen and irrad.	210	0

ing conditions indicated that the radio resistance of this organism (as compared to air-packed samples irradiated at room temperature) was increased by irradiating under the following conditions: nitrogen packing; vacuum packing; freezing and vacuum packing; and freezing.

Sterility tests made on different vegetable products inoculated with 160 to 1,800 spores of *Cl. sporogenes* per gram indicated that a dose of 1.5×10^6 rep to 2.0×10^6 rep was necesary to attain a destruction sufficient to provide no growth in any of ten samples.

It is probable that the following vegetables may be irradiated at levels sufficient to provide commercial sterility without the development of unacceptable irradiation flavors: green beans, brussel sprouts, and sweet potatoes. Sweet potatoes were always scored higher than heat processed controls and were entirely acceptable after a storage period of eight weeks at 68° F.

Halibut and fishcakes were not adversely affected in flavor by irradiation doses necessary to prevent spoilage in such products held at 37° C. It was found that fresh halibut was much less affected by irradiation treatment than was defrosted frozen halibut.

The flavor of dried prunes and raisins was not affected by irradiation doses sufficient for the destruction of molds and various forms of insects.

Most of the ascorbic acid in asparagus was destroyed by irradiating at a level sufficient to prevent bacterial spoilage. Only slight losses were encountered in broccoli and spinach treated in the same manner. Irradiation while vacuum packed or frozen prevented losses in chlorophyll to a significant extent.

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Sedimentation of Milk Proteins as a Function of Certain Ions

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SOLUBILITY AND DISPERSIBILITY are important factors in spray-dried milk intended for beverage purposes. There is abundant evidence *(17)* that variations in the mineral composition of milk result in both physical and chemical changes, and the decrease in solubility of dry milk as a result of processing has been shown to be related *(9, 13)*, among other factors, to its salt balance. The effect of minerals on coagulation of milk proteins has been emphasized, and calcium especially has been shown to play an important role in relationship to the effects of heat on protein denaturation and flocculation *(2, 5, 18)*.

In the present investigation changes in the nature of milk colloids caused by changes in mineral composition, particularly calcium, and denaturation of proteins due to heat have been followed by examination of the sediment fraction obtained by high speed centrifugation *(3, 16, 19, 20)* of milk with a Sharples Supercentrifuge. Ion exchange processes *(1, 4, 10)*, sequestering agents, and electrolytes have been used to remove or alter the mineral components in the milk under study.

EXPERIMENTAL AND RESULTS

Cations were removed from milk by the use of the mixed bed technique *(1)* employing the resins, Amberlites IR-45 and IRC-50, in the ratio of 3:2. Centrifugation was accomplished using a Sharples Supercentrifuge with steam driven head and a 1.75 inch diameter batch bowl. The speed used, unless otherwise specified, was 40,000 R.P.M. (39,400 x g) for a period of 15 minutes.

When addition of ions was made to milk, concentrated solutions were added to avoid diluting the milk by more than 2%. The treated milk was thoroughly stirred and allowed to stand overnight in a refrigerator before being examined. Analyses for Ca, Na, P, Mg, K and ash were made by published methods *(7, 8, 11, 12, 14, 15)*.

TABLE 1
Optical density and sedimentation as function of calcium level in fresh and dried non-fat milk

Type of milk	Ca^{++} removed %	O.D.—1:50 Dil.	Sediment—% total milk solids
NFP[1]	0.0	0.60	34.9
NFP[1]	24.0	0.49	27.0
NFP[1]	37.0	0.36	20.0
NFP[1]	44.5	0.28	18.4
NFP[1]	85.3	0.06	2.6
Fluid Fresh	0.0	0.44	26.4
Fluid Fresh	24.0	0.36	23.0
Fluid Fresh	43.5	0.20	7.3
Fluid Fresh	59.0	0.04	6.9
Fluid Fresh	83.6	0.02	0.0

[1] Reconstituted non-fat powder.

Effects of ion exchange. Data in Table 1 and Figures 1 and 2 indicate the effect of removal of calcium on the quantity of sediment obtained by centrifugation. Sediment quantity decreases with increasing demineralization in both reconstituted spray-dried and fresh fluid whole milk. Spray-dried milk[4] yielded more sediment at comparable calcium levels than did fresh whole milk or fresh whole milk heated at 170° F. for 30 minutes. The amounts of sediment obtained from spray-dried samples with approximately 30% calcium removed were comparable to those of non-dried milks of original calcium contents.

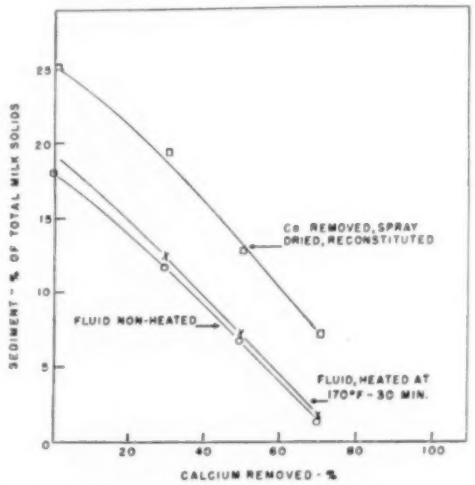

Figure 1. Relationship of calcium content to quantity of sediment in fluid and reconstituted spray dried whole milk.

The optical densities of both fresh fluid and spray-dried non-fat milk decrease as calcium is removed, Table 1, Figure 2; however, at comparable calcium levels the optical density of the spray-dried product is consistently greater than that of fresh fluid milk. Optical density measurements were made with the Evelyn Spectrophotometer using the 420 mμ filter *(6)*.

Effect of addition of calcium ion. Data shown in Table 2 and Figure 3 indicate that adding calcium to milk altered the colloidal nature of milk protein as shown by the increased quantity of proteins in the sediment, and resulted in the formation of additional calcium-protein complexes *(16)* as indicated by a greater quantity of calcium in the sediment fraction. Removal of calcium by ion exchange *(1)* had the effects as shown in Tables 1, 2, 3a and 3b and Figures 1, 2, and 3.

TABLE 2
Effect of alteration of calcium balance in whole milk on the composition and pH of supercentrifuged sediment fraction

Calcium level (% of normal)	Total solids g./100 ml. milk	A Protein (N x 6.38) g./100 ml. milk	B Calcium mgs./ 100 ml. milk	A/B Ratio	pH[3]
200[1]	3.22	1.98	91.4	21.7	6.6
155[1]	2.79	1.83	73.1	25.1	6.8
130[1]	2.47	1.73	57.4	30.2	6.8
100 (control)	2.29	1.59	52.4	30.5	7.0
75[2]	1.16	0.79	24.5	32.2	7.0
45[2]	0.75	0.49	12.2	40.1	7.3

[1] Calcium was added as a 15% solution of $CaCl_2$ in water.
[2] Calcium was removed by a mixed bed of Amberlites IR-45 and IRC-50 ion exchangers in a column containing a ratio of 3:1 of these resins.
[3] The pH of the treated milk before centrifugation was maintained constant.

[4] The solids content of reconstituted spray-dried milks was adjusted to the levels of the fluid milks used.

Effect of substitution and addition of various cations. An investigation was conducted to determine the effects of magnesium, sodium, potassium, citrate, and phosphate ions on non-fat fresh milk and reconstituted spray dried milk. Magnesium and calcium ions were added as 1M while salts, sodium and potassium ions were added as 2M solutions of the chloride. Sodium citrate and sodium orthophosphate supplied the citrates and phosphate ions, respectively. Data in Tables 3a and 3b show the effects on the composition and quantity of the sediment following substitution in ion-exchanged milk of equivalent quantities of magnesium, potassium, calcium, and sodium for varying levels of the original native milk calcium in a completely demineralized milk. Figure 5 and Table 6 illustrate the increase in optical densities resulting when these cations were returned to deionized milk. When calcium was added the optical density increased to a value close to that of the original milk. That was not true, however, when magnesium, sodium, or potassium was substituted for calcium. In the latter instances the optical density remained low. Examination of data in Table 3a and 3b shows that while the addition of Mg^{++} ion results in sediment formation equivalent to about 60% of that obtained by addition of Ca^{++} ion, the quantity of mg^{++} ion found in the sediment was about 6% that of Ca^{++} ion, and the optical density was about 20% that obtained by addition of Ca^{++} ion, Table 6, Figure 5.

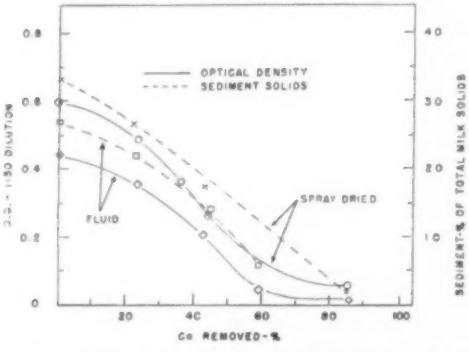

Figure 2. Optical density and sedimentation as functions of calcium level in fluids and spray dried non-fat milk.

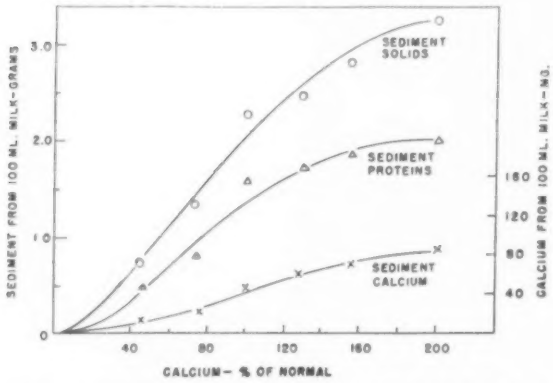

Figure 3. Effect of alteration of calcium in fluid milk on sediment composition.

Effect of addition of phosphate and citrate ions on sedimentation. Addition of phosphate ion, in an aqueous solution, did not affect the quantity of sediment and protein-bound calcium and phosphorus to any significant extent; however, addition of citrate ion, in an aqueous solution, caused a decrease in the quantity of sediment and protein-bound calcium and phosphorus, Table 4, Figure 4.

TABLE 3a

Effect of substitution of cations for calcium on quantity of sediment solids [1]

Percent Ca^{++} removed by ion exchange	Grams sediment from 100 ml. of ion exchanged milk	Grams of sediment solids from 100 ml. milk when Ca^{++}, Mg^{++}, Na^{+} or K^{+} [2] replaces removed calcium			
		Grams sediment when Ca^{++} is returned	Grams sediment when Mg^{++} replaces Ca^{++}	Grams sediment when Na^{+} replaces Ca^{++}	Grams sediment when K^{+} replaces Ca^{++}
0	2.54	.....	.....	.....	.....
15	2.15	2.35	2.22	2.12	2.05
30	1.78	2.17	2.05	1.73	1.58
60	0.58	2.45	1.90	0.68	0.58
100	0	2.50	1.50	.....	.....

[1] Sediment obtained by centrifuging milk in a Sharples Centrifuge at 40,000 RPM for a period of 15 minutes.

[2] Mg^{++} and Ca^{++} added as 1M solution, Na^{+} and K^{+} added as 2M solution of the chlorides.

TABLE 3b

Effect of substitution of certain cations for calcium on quantity of these cations in sediment [1]

Percent Ca^{++} removed by ion exchange	Mgs. Ca^{++} in sediment from 100 ml. of ion exchanged milk	Mgs. of added [2] cations in sediments from 100 ml. milk in which Ca^{++}, Mg^{++}, Na^{+}, or K^{+} replaces removed calcium			
		Mgs. Ca^{++} in sediment when Ca^{++} is replaced	Mgs. of Mg^{++} in sediment when Mg^{++} replaces Ca^{++}	Mgs. of Na^{+} in sediment when Na^{+} replaces Ca^{++}	Mgs. of K^{+} in sediment when K^{+} replaces Ca^{++}
0	53.5	.....	.....	.....	.....
15	40.0	50.0	4.5	3.5	1.3
30	27.2	47.0	6.0	2.0	1.0
60	16.6	51.0	4.0	1.5	0.5
100	0	53.5	3.0	.....	.....

[1] Sediment obtained by centrifuging milk in a Sharples Centrifuge at 40,000 RPM for a period of 15 minutes.

[2] Mg^{++} and Ca^{++} added as 1M solution, Na^{+} and K^{+} added as 2M solution of the chlorides.

Effect of addition of sequestering agents. Addition of a 10% aqueous solution of a chelating agent [b] sufficient to sequester from 5% to 100% of the total calcium and magnesium in the samples, resulted in a decrease of the optical density of the resultant non-fat milks. The optical density and sedimentation effects were similar to those as a result of ion exchange removal of calcium from milk, Tables 5 and 6.

DISCUSSION

Data presented in this paper point out the importance of the salt balance and especially of the calcium level in

[b] Disodium Ethylene Diamine Tetracetate dihydrate-sequestrene NA2.

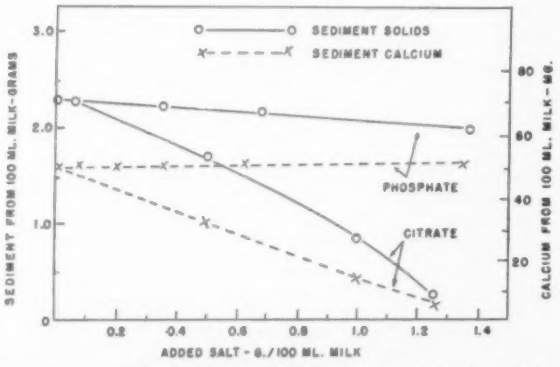

Figure 4. The effect of addition of sodium citrate and disodium phosphate on milk sediment.

TABLE 4
The effect of addition of sodium citrate and sodium phosphate on milk sediment

Sample number	Citrate added gm./100 ml.	Total solids gm./100 ml.	Nitrogen	Ash	Fat	Ca	P	Na
			Mg. per 100 ml. milk					
1	1.00	0.82	76.0	72.0	106.6	14.3	6.8	8.0
2	0.50	1.66	165.4	131.8	300.0	32.7	18.9	5.5
3	0.25	2.16	244.4	169.0	306.7	44.5	27.0	5.0
4	0.15	2.08	215.1	162.3	293.3	42.9	24.8	13.0
5	0.05	2.30	242.1	170.0	333.3	49.6	27.7	5.1
6	0.025	2.34	244.2	170.8	300.0	51.1	28.8	6.7
7	0.0	2.28	242.6	171.0	313.3	50.1	27.7	5.1
	Phosphate added gm./100 ml.							
8	1.35	2.02	195.2	206.2	220.0	51.6	28.1	18.3
9	0.67	2.15	239.3	206.8	280.0	51.7	35.8	8.5
10	0.34	2.18	226.5	169.0	253.3	50.1	31.1	11.3
11	0.20	2.27	235.4	179.3	320.0	50.6	32.7	8.2
12	0.07	2.30	238.2	181.2	326.7	50.6	34.8	7.4
13	0.035	2.29	242.8	167.0	333.3	50.1	29.6	7.0

TABLE 5
The effect of sequestration of calcium non-fat milk[1] on quantity and composition of milk sediment

Sequestrene[2] NA2, grams	$Ca^{++}+Mg^{++}$ Sequestered, %	O. D. 1:50 Dil.	Total Solids	Protein	Ash	Calcium	Phosphorous	Magnesium	Sodium
			g./100 ml. milk		Mgs./100 ml. milk				
1.32	100	.043	0.17	0.11	9.0	0.4	1.3	N.F.	5.2
0.61	50	.082	0.48	0.31	27.0	0.4	3.0	N.F.	1.2
0.31	25	.129	1.53	0.58	99.5	22.6	17.5	1.2	1.5
0.15	10	.141	2.05	0.82	146.5	39.4	26.2	2.3	4.4
0.08	5	.150	2.42	1.76	179.5	50.5	32.4	3.2	4.3
0	0	.161	2.55	1.84	197.0	56.3	36.3	3.5	3.9

[1] Supercentrifuged at 40,000 RPM (39,400 x g) for 15 minutes.
[2] Ethylene diamine tetracetate dehydrate added as 10% solution in water to sequester given percentages of milk calcium plus magnesium.

influencing protein changes which occur during heat processing of milk. Less sediment was found in fresh and in heated milk than in reconstituted spray-dried milk. Calcium removal prior to spray drying decreased the quantity of sediment obtained from the reconstituted product. When calcium was decreased by 30% prior to spray drying, Figure 1, sediments comparable to those from fresh milk were obtained.

Although various cations are removed by the ion exchange process, the evidence obtained by sedimentation studies shows that calcium is of primary importance in determining the particle nature of milk proteins. Calcium continued to combine with the milk proteins when added at higher than normal levels as shown in Figure 3. This may be compared to the effect produced by the addition of sodium and potassium which did not form insoluble complexes. When magnesium was substituted for calcium in equivalent quantities, its effect on sediment formation was less than that of calcium. Since the quality of magnesium in milk is approximately one-tenth that of calcium, the possibility of flocculation due to magnesium would appear to be slight in comparison with that due to calcium. While the addition of calcium resulted in an increase of optical density, the addition of magnesium, sodium or potassium was without effect in this respect, Table 6. The mechanism responsible for the formation of insoluble milk protein-calcium complexes has been stated *(18)* to be due to the combination of calcium with the reactive carbonyl and amino groups of the protein molecule. The resultant intermolecular bridges lead to larger aggregates and consequent coagulation.

TABLE 6
The effect of substitution of cations on optical density in demineralized milk[1]

Cation solution added ML[2]	Cation added Ca^{++}	Mg^{++}	Na^{+}	K^{+}
	Optical density of milk 1:50 dil.			
0	.039	.039	.039	.039
16	.114	.066	.035	.030
24	.158	.066	.035	.028
32	.260	.066	.033	.027
40	.337	.092	.032	.026

[1] Non-fat milk.
[2] Mg^{++} and Ca^{++} as M solution of chlorides per liter of non-fat fluid milk. Na^{+} and K^{+} as 2M solution of chlorides per liter of non-fat fluid milk.

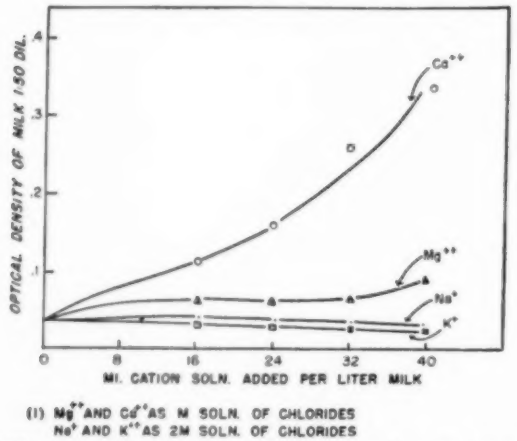

Figure 5. The effect of substitution of cations on the optical density of milk.

SUMMARY

Sedimentation studies, using a Sharples Supercentrifuge, of fluid and reconstituted spray-dried milk indicate that of the chief milk cations only calcium and magnesium tend to form insoluble complexes with proteins. Magnesium has less effect than calcium, whereas sodium and potassium are without effect in this respect.

Addition of calcium over normal levels increased the quantity of sediment and the optical density of milk, but removal of calcium by resinous ion exchange, or the use of a sequestering agent, reversed this effect. Neither the sediment composition nor the optical density of milk changed significantly when disodium phosphate was added up to 1% levels, whereas the addition of sodium citrate to the same levels caused a decrease of more than 50% in both the quantity of sediment and the optical density.

Reconstituted spray-dried whole milk yielded more sediment than fresh whole milk or whole milk heated at 170° F. for 30 minutes; however, by reduction of the calcium content of spray-dried whole milk the quantity of sediment was reduced to the levels obtained with fresh whole milk.

The nature of protein colloid particles in both fresh and spray-dried milk altered with calcium removal so that no separation of sediment was effected under a force of 39,400 x g applied for a period of fifteen minutes in a Sharples Supercentrifuge when the calcium level was one-third of normal.

Acknowledgment

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The Effect of Antioxidants on Frozen Ground Pork[a]

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(Manuscript received March 12, 1956)

Pork and pork products do not keep as well as most other meats when held in freezer storage. Some of the major changes in meat stored at temperatures below freezing are due to the oxidation of the fat. Rancidity development during frozen storage of meats is influenced by several factors, including the temperature of storage, the length of storage, the effectiveness of packaging materials and methods, the character of the fat of the meat, and the effect of added materials such as seasonings. Considerable research has been done investigating the effects of most of these factors on the keeping quality of meat held in freezer storage. Until recently, however, comparatively little study has been made concerning the addition of materials to the meat specifically for their antioxidant properties. An antioxidant that could be used with meats held in frozen

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storage that is effective, readily available, comparatively inexpensive, easily usable, and acceptable from the palatability standpoint, would be of great value to the homemaker who preserves pork and pork products by freezing.

Monosodium glutamate has been used in food primarily to enhance flavor and improve product acceptability. Norton, Tressler, and Farkas *(5)* reported that in addition to improving the texture and flavor of hams, bacon, and sausage, MSG also demonstrated some properties of an antioxidant. Kemp *(2)* found that MSG increased the desirability of seasoned, frozen pork sausage after 4 months' storage. In both studies cited, only organoleptic tests were made to determine rancidity. Soybean flour is an effective antioxidant for lard. Overman found that soybean flour delayed rancidification of pastries made with lard when the raw and cooked pastries were stored at 0° F. (—17.8° C.) for six months *(7)* and were held at 50° C. (122° F.) until rancid *(8)*. Butylated hydroxyanisole (BHA) has been found effective when used with frozen turkeys *(3)* and in creamed turkey *(1)*. Because it is heat-stable and can be added directly to the food product *(1)*, it should be useful in both raw and precooked meat products.

This study investigates the effect of monosodium glutamate, butylated hydroxyanisole, and soybean flour on the development of rancidity in frozen ground pork. These substances have demonstrated antioxidant properties under other test conditions. Since the problem of rancidity development in raw pork is entirely different from that of cooked pork *(12)*, the effect of the antioxidants was studied in both raw and precooked pork held in freezer storage. Tests for rancidity development included both organoleptic judgments and peroxide determinations.

EXPERIMENTAL PROCEDURE

Ground pork with a fat content of approximately 40% was obtained from the Department of Animal Industry. The meat was divided into 8 lots and treated as follows:

1. Control group—no treatment material.
2. Tenox BHA (2 tertiary butyl-4-hydroxyanisole and 3 tertiary butyl-4-hydroxyanisole) added at 0.02% of the fat content.
3. Full-fat soybean flour added at 2.5% of the weight of the meat.
4. Full-fat soybean flour added at 5.0% of the weight of the meat.
5. Full-fat soybean flour added at 7.5% of the weight of the meat.
6. Monosodium glutamate added at 0.10% of the weight of the meat.
7. Monosodium glutamate added at 0.15% of the weight of the meat.
8. Monosodium glutamate added at 0.30% of the weight of the meat.

The meat was thoroughly mixed, ground once, and divided into lots. The treatment material was added to each lot of meat, mixed well by hand, and ground twice through a power grinder to insure thorough mixing.

One half of the meat was cooked prior to freezer storage and the other half was stored raw. In the preparation of the samples to be stored raw, the meat was weighed into 50-g. patties, which were wrapped in moisture-vapor-proof cellophane using a drugstore wrap, and sealed with pressure sensitive tape. The patties were coded and packed four to a box in cardboard cartons.

The meat for the cooked samples was placed in baking pans, covered with aluminum foil, put into a 325° F. oven, and cooked to an internal temperature of 85° C. The cooked meat was divided into 200-g. portions and placed in polyethylene bags with some of the drippings. The bags were coded and placed in cardboard cartons for freezer storage. All meat was placed in frozen storage at —10° F. (—23.3° C.).

In order to observe the effect of the various treatment materials, pH determinations were made on the raw ground pork. Twenty-five grams of pork and 125 ml. of distilled water were whirled in a Waring blender for 2 minutes. The mixture was filtered, and the pH of the filtrate determined with a MacBeth pH meter.

Peroxide determinations were made on the raw ground pork, and the treated meat was analyzed after storage periods of 2, 4, 6, 9, 12, 15, and 18 months. The method described by Watts and Peng *(12)* was used to extract the fat from the meat. A modification of the Wheeler iodometric procedure for determining peroxide values *(10)* was selected to measure the peroxides present in the extracted fat.

A taste panel of 6 judges, chosen for their availability and interest in the study, judged the samples for palatability when fresh and after 2, 4, 6, 9, and 12 months of storage. Samples were removed from the freezer and held at room temperature for 2½ hours before cooking. The meat was unwrapped, placed in appropriately coded small loaf baking tins, covered with aluminum foil, and baked at 325° F. for 1 hour. Twenty-five gram samples were then placed in warm coded 50 ml. glass beakers, and judged according to a randomized complete block design providing for 3 replications of each sample with 6 samples judged at a time. A patty made from fresh ground pork obtained at a downtown meat market was served for purposes of comparison. Samples were rated for flavor, odor, and acceptability on a score card classified as follows: 10-9, *desirable*; 8-7, *moderately desirable*; 6-5, *acceptable*; 4-3, *slightly undesirable*; 2-1, *undesirable*. Intensity of rancidity was indicated by √ = weak, √ √ = moderate, and √ √ √ = strong after the last item on the score card, *rancidity present*.

The data obtained on acceptability ratings and peroxide determinations were analyzed statistically by analysis of variance *(6)*.

RESULTS AND DISCUSSION

Peroxide determinations. The comparisons made, and the significance of differences obtained in an analysis

TABLE 1
Analysis of variance [1]

	Peroxide number		Acceptability	
	Raw	Cooked	Raw	Cooked
Treatments	**	**	**	**
MSG, Soy, BHA vs. Control	*	—	—	—
MSG vs. Soy vs. BHA	**	**	**	**
Among MSG	—	—	—	—
linear	—	—	—	—
quadratic	—	—	—	—
Among Soy	—	—	**	—
linear	—	—	**	—
quadratic	—	—	*	—
MSG vs. Control	**	—	—	—
Soy vs. Control	**	*	**	—
BHA vs. Control	**	**	—	—
Storage Times	**	**	—	—
linear	**	**	—	—
residual	**	—	—	—
T x S interaction	**	—	—	*
Judges			**	**
T x J			**	**
S x J			**	**
T x S x J			**	—

[1] * indicates significance at 5% level.
** indicates significance at 1% level.
— indicates no significance.

of variance of the peroxide values and acceptability scores are shown in Table 1.[6] Significant differences due to treatment and length of storage were found both in pork stored raw and pork cooked prior to freezer storage. The difference among the three levels of MSG or soybean flour was not significant in either the raw or cooked pork. This finding is confirmed in the studies of Overman with soybean flour *(7)* and Kemp *(2)* with monosodium glutamate.

Figure 1 shows the relative antioxidant effects of the various treatments. It can be seen that the cooking

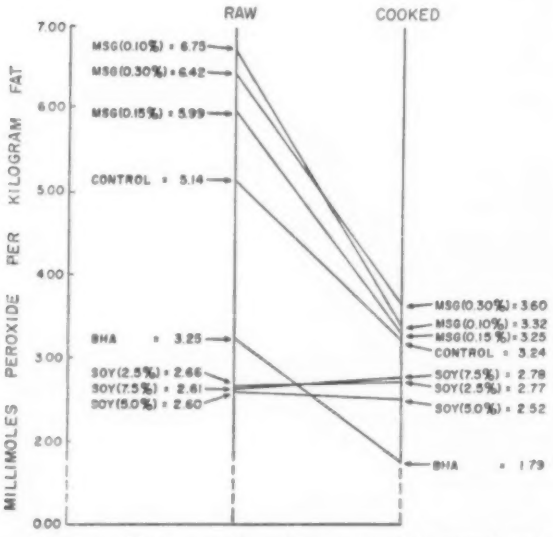

Figure 1. Mean peroxide values for treated ground pork stored for 18 months at —10° F. (—23.3° C.).

process alone retarded peroxide development markedly. The heme pigments, such as hemoglobin and myoglobin, probably catalyze the oxidation of unsaturated fats in meats. Watts *(11)* attributes the loss of pro-oxidant activity upon heating to the coagulation of the hemoglobin or myoglobin, which eliminates their catalytic effect on fat oxidation.

Peroxide values higher than the control were obtained from both raw and cooked samples treated with MSG, but in the case of cooked pork this difference was too small to be significant. The accelerating effect from MSG added to raw pork in the study resembles the acitvity of sodium chloride and other salts. Salts which have been found to accelerate rancidity in raw pork include sodium chloride, sodium nitrate, sodium acetate, magnesium chloride, and also potassium nitrate. Potassium chloride and sodium sulphate were without effect *(12)*.

Soy and BHA retarded oxidation in both raw and cooked pork; in raw pork soy was the more effective, whereas in cooked pork BHA showed the lowest peroxide values. The fact that soy-treated samples showed no further reduction in peroxide number after cooking would suggest that not only the fat oxidase but also a part of the antioxidant property exhibited by soy in the raw pork was destroyed by heat. On the other hand, BHA, which is known to be heat stable, showed a retarding effect on peroxide formation additional to that expected from cooking alone.

The effect of storage time on peroxide development is shown in Figure 2. Since statistical analysis indicated that the differences among the 3 levels of soy and MSG were not significant, the line plotted for each treatment represents the mean of the 3 values. The peroxide values increased significantly with increasing storage. None of the samples, raw or cooked, became rancid during the first 12 months of storage. Watts *(12)* used 10 millimoles of peroxide/kg. of fat as an arbitrary rancidity point. In this study, the highest peroxide value in any sample at the twelfth month was 8.0 (MSG at 0.10%), and all others were less than 6.5. The effect of storage time was most pronounced in the control and MSG-treated pork stored raw; at 18 months these samples had more than doubled their twelfth month peroxide values. The effect observed in MSG-treated samples again resembled the effect from sodium chloride. Watts *(11)* noted that when solutions containing salt lose moisture (as might happen in prolonged freezer storage of meat), so that salt is thrown out as a thin surface film and brought into contact with the fat over a wide surface, rancidity is greatly accelerated.

pH determinations. Watts *(12)* reported that pH had a marked effect on the rate of rancidity development in frozen raw pork sausage, but little effect on precooked sausage. Meat with lower pH values (6.1 or

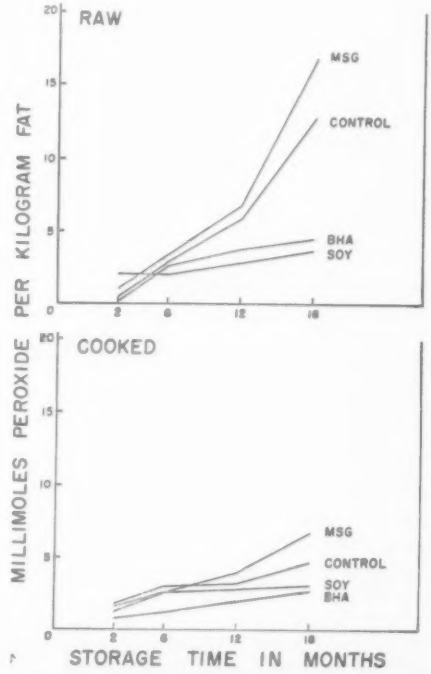

Figure 2. Peroxide development in raw and cooked ground pork during 18 months of freezer storage.

[6] Calculations performed by the Statistical Laboratory, Montana State College.

below) developed rancidity faster than meat with the higher values. In this study, after the addition of the various treatment materials, the mean pH values for each group were: control, 5.95; BHA, 6.0; MSG, 6.05; and soy, 6.27. The increase in pH due to the addition of soybean flour to the raw ground pork may be related to the reduced peroxide development in these samples (Figures 1 and 2).

Palatability judgments. Of the 3 characteristics of the meat which were evaluated, acceptability was considered the best over-all estimate of palatability. Scores for this factor were subjected to statistical analysis.

Figure 3 shows the acceptability ratings for the various treatments, and Table 1 gives the significance of these differences. Although the cooking process retarded peroxide development significantly, it had only a small effect on acceptability. Under either storage condition, the samples containing MSG were preferred to the control, and the soy samples (with the exception of the raw pork containing 2.5% soy) were judged least acceptable. The soy flavor was prominent enough to be detected. The BHA-treated pork did not differ from the control when stored raw, but was slightly preferred to the control when cooked prior to storage.

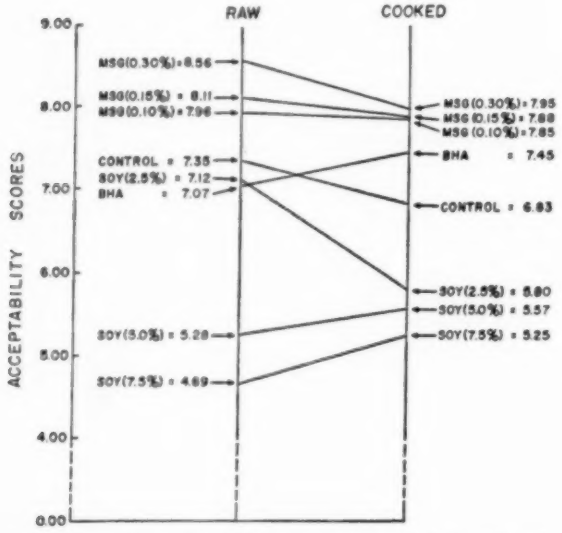

Figure 3. Mean acceptability scores for treated ground pork stored for 12 months at —10° F. (—23.3° C.).

Although the effect of storage time on acceptability was not significant, the treatment-storage time interaction in pork cooked prior to storage was significant at the 5% level (Table 1). Judges' scores for the control pork, and the meat containing MSG or BHA, declined slightly as storage time increased. The samples containing soy, however, received their highest acceptability ratings at the sixth month period, and then declined.

In spite of the fact that peroxide determinations indicated that in both raw and cooked ground pork the MSG-treated samples were progressing most rapidly toward rancidity, the organoleptic judgments on palatability showed these samples to be more desirable than any other treatment group. This finding is interesting in view of the work reported by Norton, Tressler, and Farkas *(5)* and Kemp *(2)*. Both of these studies found that MSG improved the desirability of frozen ground pork, as determined by organoleptic judgments alone. Thus, though peroxide determinations in this experiment suggested more pro-oxidant than antioxidant activity on the part of monosodium glutamate, organoleptic judgments showed that up to 12 months of storage its seasoning properties actually increased the acceptability of frozen ground pork. Peryam *(9)* reported on hamburger which had been made "rancid" by exposure to ultra-violet light. The addition of 0.6% MSG to the "rancid" meat prior to cooking caused it to be slightly preferred to a control of fresh hamburger, and definitely preferred to a "rancid" sample to which no MSG had been added. The 0.6% concentration was higher than that used in this study. Since palatability tests could not be continued after 12 months, it is not known whether the desirable effects of MSG would have been maintained in the presence of the rancidity indicated at the fifteenth and eighteenth months of storage.

SUMMARY AND CONCLUSIONS

Ground pork was divided into 8 lots and treated as follows: three groups contained 0.10%, 0.15%, and 0.30%, respectively, of monosodium glutamate; three groups contained 2.5%, 5.0%, and 7.5%, respectively, of full-fat soybean flour; one group contained 0.02% butylated hydroxyanisole; and the last lot, a control, contained no treatment material. The lots were divided in half; one half was frozen raw, and the other was cooked prior to storage. Peroxide determinations were made at intervals up to 18 months of storage, and palatability tests were made at corresponding intervals up to 12 months.

The cooking process alone markedly retarded oxidation in all groups except those with added soybean flour. There was little difference between the soy-treated pork stored raw or that cooked before storing. Peroxide numbers showed no significant differences among the three levels of MSG or of soy.

Although soybean flour was an effective inhibitor of peroxide development in both raw and cooked pork, its acceptability rating on organoleptic tests was much lower than the control in all cases except one: when stored raw, samples with soy at 2.5% were about equal to the control in acceptability.

MSG received the highest ratings on palatability judgments in both the pork stored raw and that cooked before freezer storage. Chemical determinations, however, indicated more pro-oxidant than antioxidant actitvity on the part of MSG, the peroxide values increasing very rapidly after the twelfth month of storage.

BHA had a significant antioxidant effect on pork stored raw, and in pork cooked prior to freezing it was the most effective of the treatments in retarding oxidation. In acceptability, it was either equal to or better than the control.

Storage time had a significant linear effect upon peroxide development, the values increasing as stor-

age time increased. There was a slight lowering of acceptability ratings as storage time increased, but this effect was not statistically significant. After 12 months of storage, the pork was essentially as acceptable as when fresh.

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Thermocouple Nomogram Construction

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A method for constructing a temperature calculation chart for use with thermocouples and ordinary potentiometers is given.

Potentiometers with cold junction compensation resistors often are either not available or hamper the use of the instrument too much to be desirable. However, in using thermocouples with a standard potentiometer for temperature control, the calculations involved are rather time consuming and may lead to error. A nomogram (alignment chart) may be constructed to solve these problems graphically and so avoid these difficulties. The best method of constructing the nomogram is by the use of a determinant.

The following paper presents a method for the construction of a temperature calculation chart for use with thermocouples and ordinary potentiometers. Starting with the relation:

$$E_{HJ} - E_{CJ} = E_T \qquad (1)$$

Where E_{HJ} = Electric potential due to the temperature of the hot junction;

E_{CJ} = Electric potential due to the temperature of the cold junction; and

E_T = The net (total) electric potential or that which is read on the potentiometer.

This equation may be represented by a determinant of the third order suitable for the construction of nomograms *(1)*:

$$\begin{vmatrix} -d_{CJ} & -s_1 \cdot E_{CJ} & 1 \\ 0 & \dfrac{s_1 \cdot s_3}{s_1 + s_3} E_T & 1 \\ d_{HJ} & s_3 \cdot E_{HJ} & 1 \end{vmatrix} = 0 \qquad (2)$$

where d_{CJ} and d_{HJ} are directional distances of the cold junction and hot junction loci relative to the total voltage locus. Their values may be chosen by trial and error as may the values of s_1 and s_3, subject only to the condition that $d_{CJ} \cdot s_3 = d_{HJ} \cdot s_1$; s_1 and s_3 are the scale factors that control the location of the voltage graduations on the 3 scales.

In using copper-constantan thermocouples in the range 60° F. to 212° F., the distances and scale factors were taken such as to be readable to 1° F. when the nomogram was placed on 8½ by 11 in. paper (Figure 1). These conditions were found to be satisfied by the determinent:

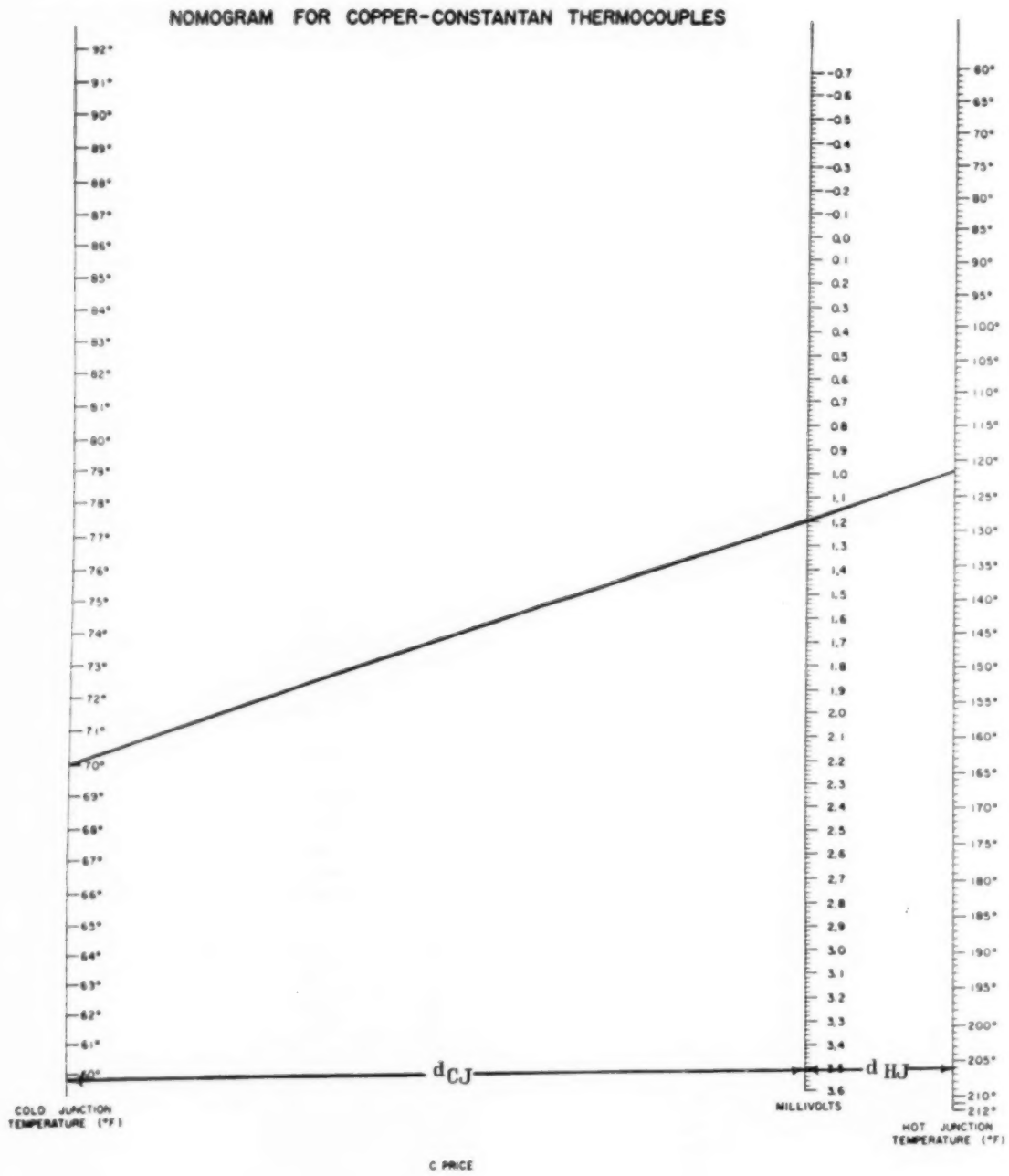
$$\begin{vmatrix} -15 & -5\,E_{CJ} & 1 \\ 0 & \frac{5}{6}\,E_T & 1 \\ 3 & E_{HJ} & 1 \end{vmatrix} = 0 \qquad (3)$$

where the left column tells us that the cold junction locus must be 15 units left (—) of the total voltage column and the hot junction locus must be 3 units right (+) of the total voltage column. The center column indicates the graduations for the cold junction locus should be expanded 5 times as much as the graduations for the hot junction column and should be inverted (—) with respect to the other two loci. The total voltage scale must be ⅚ as magnified as the hot junction scale. Other nomograms may, of course, be constructed with the aid of *(2)*.

STEPS INVOLVED

The steps involved in the construction of the nomogram are as follows:

1. The three vertical lines are laid off.
2. The lines are marked off in millivolts.



3. Using a millivolt-temperature table for the thermocouple metals in use, the cold junction and hot junction columns are rescaled to read directly in degrees.

An example of the use of the nomogram will be given using Figure 1. If the cold junction temperature has been found to be 70° F. and the voltage is 1.2 millivolts, a straight line which connects these two points may be extended to intersect with the hot junction scale. Thus the hot junction temperature is seen to be approximately 122° F.

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Factors in the Analysis of Mass Panel Wine-Preference Data

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DIFFERENT METHODS OF PRESENTATAION and types of questionnaire have been used to test wines for consumer acceptance and preference *(2)*. Reproducibility of mean scores was obtained for the same wine tested in different comparisons at various times and days *(8)*, using a nine-point hedonic scale *(9, 13)*. Also, a definite bias was noted for the first sample served in two-sample comparisons *(2, 10)*. The studies incorporating the hedonic scale were conducted in 1953, 1954, and 1955 with two California fairs as locales.

The 1955 studies were used as the basis for the present paper, with a direction primarily toward a refinement of the methodology of the hedonic scaling method. An attempt was made to determine the extent of the order bias and the degree of correlation between responses for two wines in paired comparison. An analysis of the data was made to determine the validity of the assumptions of normality and homogeneity of variance for the scoring systems used and also to derive practical conclusions on the basis of tests of significance.

PRACTICAL CONSIDERATIONS

To evaluate consumer preferences, large numbers of judgments are usually necessary in order to stabilize the average measure of preference. The standard deviation of the mean value varies as the reciprocal of the square root of the number of judgments. Since a large number of judgments tends to increase the sensitivity of the tests of statistical significance applied to differences between mean values, a situation is developed whereby small differences in mean response will be of doubtful practical value for determination of the preference, even though statistically significant at the usual level of 5%.

From a practical consumer preference standpoint, one should be positive that a definite preference exists before attempting exploitation of the preference. A classical statement of this concept is that the error of the first kind should be kept at a very low level. An error of the first kind is the chance that a difference will be found when none exists, in contrast to an error of the second kind, which is the probability that a real difference may be overlooked. The errors of the first and second kind have been discussed *(1, 15)*. Since these two errors are dependent upon one another, a more stringent level for the error of the first kind allows a higher probability for overlooking a preference. In consumer acceptance studies, the failure to find the preference is not dangerous while the acceptance of a false hypothesis is fatal.

With the foregoing thought in mind, it is suggested that tests of significance for consumer preference should be made at the chance probability level of 0.1% for errors of the first kind when large numbers (greater than 100) are employed. This would apply generally to the *t-test* and *F-ratio*.

The usual tests of significance assume normal distributions and homogeneity of variance. Appreciable departures from normality have been found to have no serious effect on the results of the analysis of variance *(3)*, but grossly skewed populations may influence conclusions derived from the *t-test* in one-tailed tests of significance. A one-tailed test arises when one item has been determined a priori to be better, or more favorably received, than another and the test is to determine whether the *more* favorable attitude is significant. However, there is no certainty whether variations in variance within groups of different samples may not invalidate the inferences made from the analysis of variance.

Another point is worthy of consideration; it is customary to manipulate the observations and/or make various assumptions in order that existing techniques may be applied. In many cases this amounts to forcing the data to conform to a specification. On the other hand, less sensitive tests may furnish all of the preference information needed without the rigid assumptions required for the more sensitive techniques. Two such non-parametric methods are the rank test *(10)* and the sign test *(4)* which may provide sufficient information for practical purposes.

EXPERIMENTAL

Questionnaires. Four forms of the questionnaire were used in the survey, all hedonic in nature. Form No. 1 (Figure 1) contained two sets of 9-point hedonic scales and was used for the two-sample comparison. Form No. 2 was similar to Form No. 1 in structure but contained only one scale, although used for two-sample comparisons. This was accomplished by placing the numerals 1 and 2 at the appropriate levels of the scale to denote the degree of liking for the wine coresponding to the numeral. Form No. 3 was similar to Form No. 1, contained but one scale, and was used for single sample presentations exclusively. Form No. 4 (Figure 2) was used for paired comparisons.

PLEASE INDICATE BY CHECK MARK

1. *Age:* 21 to 35_____ 35 to 50_____ Over 50_____
2. *Sex:* Male_____ Female_____
3. *How often do you drink wine?*
   Several times a week_____
   A few times a month_____
   A few times a year or never_____

TASTING PROCEDURE

Carefully taste the wine samples served you. After tasting check your reactions on the scales below.

PLEASE TASTE SAMPLE NO. 1 FIRST

SAMPLE 1	SAMPLE 2
_____Like Extremely	_____Like Extremely
_____Like Very Much	_____Like Very Much
_____Like Moderately	_____Like Moderately
_____Like Slightly	_____Like Slightly
_____Neither Like Nor Dislike	_____ Neither Like Nor Dislike
_____Dislike Slightly	_____Dislike Slightly
_____Dislike Moderately	_____Dislike Moderately
_____Dislike Very Much	_____Dislike Very Much
_____Dislike Extremely	_____Dislike Extremely

Figure 1. Details of Questionnaire Form 1.

PLEASE INDICATE BY CHECK MARK

1. *Age:* 21 to 35_____ 35 to 50_____ Over 50_____

2. *Sex:* Male_____ Female_____

3. *How often do you drink wine?*

Several times a week_____

A few times a month_____

A few times a year or never_____

TASTING PROCEDURE

Carefully taste the wine samples served you. After tasting check your reactions on the scales below.

PLEASE TASTE SAMPLE NO. 1 FIRST

I prefer sample 1 over sample 2 EXTREMELY _____
I prefer sample 1 over sample 2 VERY MUCH_____
I prefer sample 1 over sample 2 MODERATELY_____
I prefer sample 1 over sample 2 SLIGHTLY _____
I have no preference _____
I prefer sample 2 over sample 1 SLIGHTLY _____
I prefer sample 2 over sample 1 MODERATELY_____
I prefer sample 2 over sample 1 VERY MUCH_____
I prefer sample 2 over sample 1 EXTREMELY _____

Figure 2. Details of Questionnaire Form 4.

Test panel. From daily invitational tastings at two California Fairs, a total of 17,200 responses was obtained.

Wines tested. A group of 3 Rosé table wines was compared for preference in sweetness. These were served in pairs in all combinations and also as single samples. The 3 wines were identical in all respects but one, that of varying sugar content. The wines contained 12% alcohol by volume and possessed a characteristic pink hue. The three reducing sugar levels were 0, 1 and 3%.

Another group was tested for preference among commercial table wines. These 3 wines were in the competitive price class and consisted of a Sauterne, a Vin Rosé and a Red table wine. The reducing sugar content for all 3 wines was at the 1% level. These wines were compared in pairs and also given as single sample presentations.

Two other comparisons were made; one, between a pale Dry Sherry and a light Dry Vermouth, and the other between a Sweet Sherry and a Sweet Vermouth.

Serving procedure. In two-sample presentations the order of serving was reversed frequently to minimize the order bias within sub-groups of age by frequency of use of wine. For overall total numbers, both orders of serving were balanced for any comparison.

Scale values. For statistical analysis of the data obtained from Forms 1, 2 and 3, the scale categories were assigned successive integers from 1 to 9, beginning at the *dislike* end. Furthermore, the difference in response for two wines by any one individual was expressed as a difference between the two numerically assigned values; a range of −8 to +8 was possible, depending upon the direction of preference.

Values for the scale in Form 4 were given as −4, −3, −2, −1, 0, +1, +2, +3, and +4 to cover the range from: I prefer sample 2 over sample 1 *extremely* to: I prefer sample 1 over sample 2 *extremely*.

All data were transferred to I. B. M. cards for convenient tabulation and reduction of error.

RESULTS AND DISCUSSION

The extent of the order bias. The bias for the first sample served, although definitely present, should not be assumed to be a constant factor. Among other considerations, it would be expected to vary with the wine comparison, the degree of difference in liking between wines, and with age and frequency of use. Table 1 shows the values of the difference in average score when tasted first and second for some of the comparisons made. The range of the difference is broad, 0.05-1.00, over the different categories and comparisons. There is a tendency for the bias to decrease with increasing age group. If this is not a fortuitous result, the explanation could be that the older person, found to be a more frequent user of wine generally, is more familiar with these wine types and consequently does not assume as critical a view toward the sample served second as do other groups. Also, it will be noted that the wine with the higher average score in any one comparison demonstrated the least overall bias.

In general, an equal total number of presentations in each of the two serving orders has been effective in eliminating the bias. However, it is conceivable that some error could remain if equal serving orders within age groups, at least, were not maintained, due to the variability of the bias. A frequent reversal of serving order during any one comparison tends to minimize this effect.

TABLE 1

Bias for order served by age and frequency of use groups

Comparison	Difference in score [1]						
	Average all groups	Age			Freq. of use [2]		
		21-35	35-50	Over 50	1	2	3
Dry Sherry vs. Dry Vermouth							
Sherry	.70	.95	.86	.26	.72	.61	.74
Vermouth	.35	.41	.30	.41	.36	.48	.35
Rosé (0%) vs. Rosé (3%)							
Rosé 0%	.53	.70	.70	.56	.81	.35	.76
Rosé 3%	.20	.45	.12	.05	.31	.27	.13
Sweet Sherry vs. Sweet Vermouth							
Sherry	.80	1.00	.76	.60	.55	1.00	.73
Vermouth	.65	.78	.66	.46	.27	.81	.83

[1] Difference in score $= \bar{X}_1 - \bar{X}_2$
where $\bar{X}_1$ = average when tasted first
$\bar{X}_2$ = average when tasted second

[2] Frequency of use
1 = several times a week
2 = few times a month
3 = few times a year or never.

Degree of correlation in two-sample comparison. It was considered pertinent to determine whether any correlation existed between responses to two wines by the individual using Form 1 or Form 2, or whether the judgments were independent. The correlation to which reference is made is the tendency for a taster to rate the two samples up or down, as a unit, depending upon some personal bias; in other words, to what extent would high scores for sample 1 tend to draw high scores for sample 2, with the same reasoning applying to low scores?

Since it was not expected that the numerical values given to the hedonic scale would be linear representations of the degree of liking, the correlation ratio *(7)* was employed. The correlation ratio is a measure of the relationship between two variables when the relationship is not linear. The significance of the correlation ratio is tested by the value of the statistic F. In any paired comparison there will be two values of the ratio, one for the correlation of wine A on wine B and the other for the correlation of wine B on wine A. These two ratios are not usually identical.

Correlation ratios were calculated for various wine comparisons, using data obtained from Forms 1 and 2. These are compared in Table 2, giving ratios and degrees of significance. There was a general signfiicant correlation for all comparisons and no essential differences were noted between the two forms of hedonic rating. However, the correlations were all small in value and are of doubtful practical significance. All that may be stated is that there was a tendency to correlate two wines in a paired comparison, a tendency which became evident when a large number of judgments were used.

TABLE 2
Comparison of Forms 1 and 2 for correlation ratios

Correlation of	Form 1		Form 2	
	Number of judgments	Ratio	Number of judgments	Ratio
Rosé 0% on Rosé 3%	514	0.12	315	0.16
Rosé 3% on Rosé 0%	514	.18*	315	0.23*
Rosé 0% on Rosé 1%	495	.25***	307	.32***
Rosé 1% on Rosé 0%	495	.20**	307	.25*
Rosé 1% on Rosé 3%	481	.17	305	.36***
Rosé 3% on Rosé 1%	481	.32***	305	.33***
Sw. Sherry on Sw. Vermouth	1218	.17***	555	.20**
Sw. Vermouth on Sw. Sherry	1218	.18***	555	.20**
Dry Sherry on Dry Vermouth	723	.23***	695	.14
Dry Vermouth on Dry Sherry	723	.26***	695	.20**

*significant at 5% level.
**significant at 1% level.
***significant at 0.1% level.

If the practical significance is questionable, the significance should tend to disappear when a smaller number of judgments are taken. When the responses are broken down into sub-categories of age group by frequency of use of wine, the significance of the correlation does disappeear in most cases, as shown in Table 3.

TABLE 3
Correlation ratios calculated for sub-group categories

Category [1]	Rosé 1% on Rosé 0%		Dry Sherry on Dry Vermouth		Sw. Vermouth on Sw. Sherry	
	Number of judgments	Ratio	Number of judgments	Ratio	Number of judgments	Ratio
A_1 and F_1	82	.31	163	.23	253	.17
A_1 and F_2	202	.10	282	.25*	421	.16
A_1 and F_3	98	.47***	125	.35*	156	.21
A_2 and F_1	100	.32	189	.34**	232	.32**
A_2 and F_2	125	.32	193	.29*	243	.01
A_2 and F_3	(1)		74	.38	95	.22
A_3 and F_1	78	.20	118	.29	183	.21
A_3 and F_2	67	.52**	87	.35	112	.26
A_3 and F_3	(1)		(1)		(1)	

(1) = too few numbers for reliable determination of ratio.
[1] A_1 = 21-35; A_2 = 35-50; A_3 = Over 50.
F_1 = several times a week; F_2 = few times a month; F_3 = few times a year or never.
*significant at 5% level.
**significant at 1% level.
***significant at 0.1% level.

There is another type of association that may appear in paired comparisons; the taster may adopt a psychological standard of reference for degree of liking depending upon the two wines being tested.

If there were no association between samples, the average score for a wine tasted first should be identical to the value obtained from a single sample tasting, within the limits of chance variability. Table 4 gives the average score for each wine when tasted first, and a comparison is made with the mean value obtained when presented as a single sample. Only two significant differences were found; that of the Rosé 0% when served first against Rosé 3% and that of Rosé 0% when tested first against Rosé 1%. Since these wines differed only in sugar content, it is reasonable to assume that the sweetness comparison was responsible for the change in reference standard associated with the degree of liking. All other comparisons revealed no essential differences in score for a wine tasted first and when tasted alone.

The assumption of normality of frequency distribution. If the cumulative frequency percentages are plotted on normal probability paper, a normal distribution will appear as a straight line, plotting the cumulative frequency percentages against the scale values.

TABLE 4
Average scores when served first in paired comparison and when served as single samples

Comparison of	Average hedonic score	
	Paired comparison	Single sample
Sweet Sherry vs. Sw. Vermouth		
Sweet Sherry when served 1st	7.1	7.2
Sw. Vermouth when served 1st	7.1	7.2
Rosé 0% vs. Rosé 3%		
Rosé 0% when served 1st	6.5**	7.1
Rose 3% when served 1st	7.5	7.4
Rosé 1% vs. Rosé 3%		
Rosé 1% when served 1st	6.9	7.1
Rosé 3% when served 1st	7.4	7.4
Rosé 0% vs. Rosé 1%		
Rosé 0% when served 1st	6.8**	7.1
Rosé 1% when served 1st	7.1	7.1
Vin Rosé vs. Sauterne		
Vin Rosé when served 1st	7.1	7.1
Sauterne when served 1st	7.3	7.3
Sauterne vs. Red table wine		
Sauterne when served 1st	7.4	7.3
Red table when served 1st	7.3	7.1
Red table wine vs. Vin Rosé		
Red table when served 1st	7.3	7.1
Vin Rosé when served 1st	7.0	7.1

**Significant at 1% level.

Figure 3 represents the cumulative frequency responses on normal probability paper for the scale values 1 to 9 for Rosé wines of 0, 1 and 3% sugar content, using Form 1. A total of 710 judgments was taken for each wine. While the curves reveal some evident deviations from linearity, these would not appear to be too severe.

If the difference in scale value, between the responses to the two wines compared by each individual, is taken as a measure of the difference response, there is available a cumulative frequency distribution for scale values ranging from —8 to +8. Figure 4 represents this distribution for the same three Rosé wines. The approach to linearity is marked. The number of judgments for each wine was 710.

The frequency distribution using Form 4, scaled from —4 to +4, presents a different picture. From Figure 5, the responses yield lines of appreciable curvature for all three Rosé wines. This departure from normality is due to the fact that the respondents did not make much

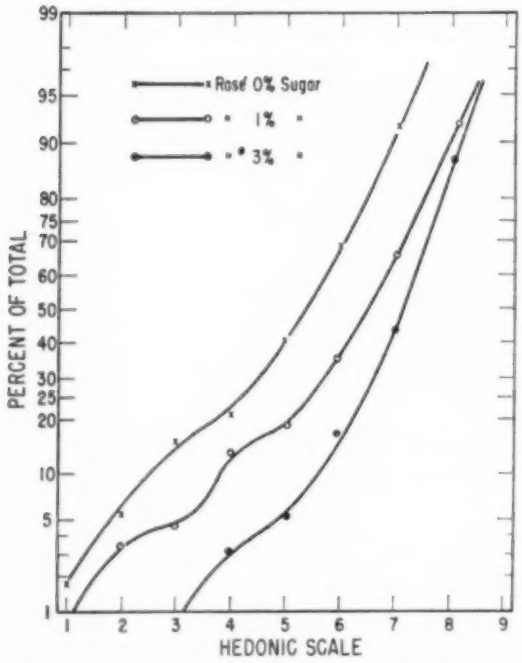

Figure 3. Cumulative frequency distribution of responses for various wines by hedonic scale, 1-9, Form No. 1.

use of the "0" or "I have no preference" category. Some transformation of the scale is indicated, but it is unknown whether such a transformation would be effective with other comparisons.

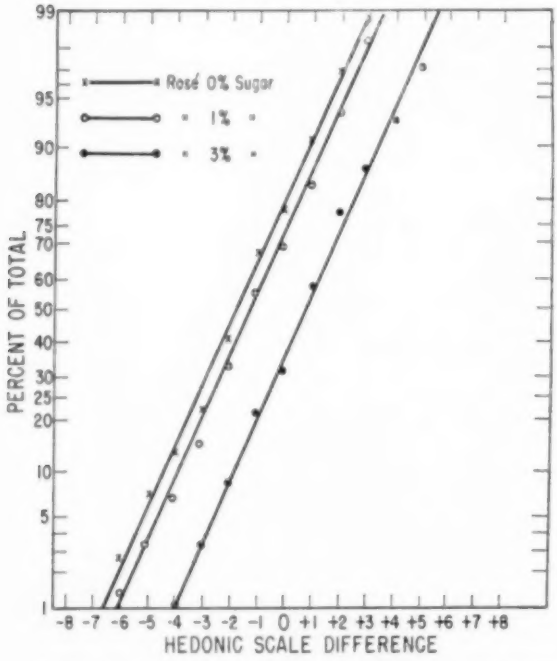

Figure 4. Cumulative frequency distribution of responses for various wines by differences in hedonic scaling of Form No. 1.

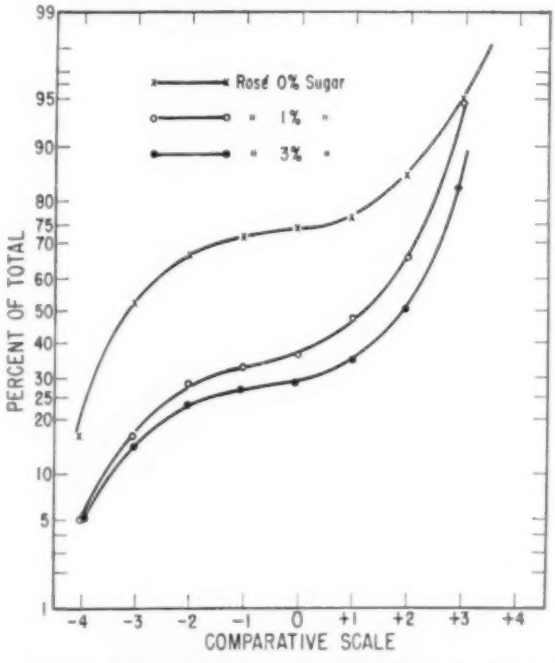

Figure 5. Cumulative frequency distribution of responses for various wines by comparative scale of Form No. 4.

Homogeneity of variance. In the comparison of Rosé wines of 0% and 3% sugar by Form 1 and the nine-point hedonic scale, a significant heterogeneity in variances was noted among the sub-categories of age by frequency of use of wine. The significance was determined by use of Bartlett's test *(5)*. The means ranged from 4.58 to 7.59. The range in variance was broad, 0.66-5.28, and appeared to vary with the mean. This effect is demonstrated in Figure 6, a plot of the variance, s^2, again the mean, M, for the Rosé (0% and 3%) comparison. The line of best fit for 36 points yielded a very

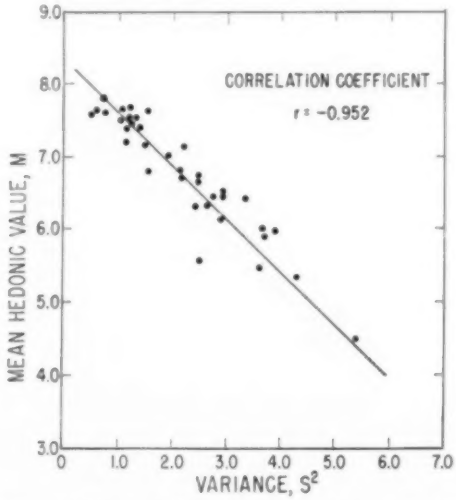

Figure 6. The variation of variance with mean value for hedonic scaling of Form No. 1.

highly significant linear relationship, $r = -0.952$. The larger the mean, the smaller the variance in the scale range studied.

To reduce the range in variance, a transformation was made by a method of successive intervals *(6)*, which, although improving the homogeneity of variance, resulted in cumbersome calculations. Furthermore, no greater sensitivity was noted using this method in tests of significance.

When the difference between scores was used, in a scale range of -8 to $+8$, there was no evidence of heterogeneity of variance.

Analysis by paired comparison. An analysis of variance for paired comparisons has been developed by Scheffé *(14)*, based upon a mathematically interesting model. The design allows for more than two stimuli to be compared by serving all possible paired combinations in both orders of presentation, one judge to each pair and an equal number of judgments in each comparison. The rating scale is similar to that of Form 4. The analysis provides tests for the significance of main preference effects, order effects, and tests the hypothesis of subtractivity. The hypothesis of subtractivity is analogous to the absence of interaction in a two-way layout and, if the hypothesis is not violated, the interpretation of the main effects becomes clearly due to a difference in the means alone. The acceptance of the hypothesis denotes that there are parameters a_1, a_2, a_3, . . . a_n, which characterize each of the n stimuli such that the average preference for one stimulus over another is the difference between the corresponding parameters.

This design and analysis was applied to preference tests between three Rosé table wines, 0, 1 and 3% sugar content. Numerical values were assigned to the scale in the range of -4 to $+4$. There were 146 judgments in each ordered comparison for a total of 876 judgments in all, since there were three comparisons for each of two orders of presentation. The results are given in an analysis of variance, Table 5.

TABLE 5
Analysis of variance using Form No. 4 for paired comparisons of three Rosé wines

	Sum of squares	Degrees of freedom	Mean square
Main effects	876.	2	438.***
Deviations from subtractivity	3.	1	3.
Average preferences	879.	3	
Order effect	308.	3	103.***
Means	1187.	6	
Error	5477.	870	6.3
Total	6664.	876	

***p = less than 0.001.

From the table, a very highly significant difference in degree of liking (main effects) and order effect is demonstrated. The hypothesis of subtractivity is accepted due to the insignificance of variance attributable to deviations from subtractivity. The three parameters a_1, a_2, a_3 (for Rosé 0, 1 and 3%, respectively) were calculated and found to be $a_1 = -0.711$, $a_2 = +0.007$ and $a_3 = +0.704$.

To test the significance of the difference in liking between any two of the wines, a "yardstick" is used,

$$Y_e = q_{1-e}\sqrt{s_e^2/2rm}$$

where s_e^2 = error variance
r = number of judgments in each ordered comparison
m = number of wines
q_{1-e} = Studentized range variable q at a confidence coefficient of 1-e.

If a confidence coefficient 1-e = 0.99 is taken, the error degrees of freedom being 870 and m = 3, then from tables *(11, 12)* the value for $q_{0.99}$ approximates 4.15. From Table 5, $s_e^2 = 6.3$ and $r = 146$, then

$$Y_{0.01} = 4.15\sqrt{\frac{6.3}{2 \times 146 \times 3}} = 0.353$$

This value $Y = 0.353$ represents the smallest difference between any two a's to be significant at the 99% confidence level. Since the differences noted, $a_2 - a_1 = 0.718$, $a_3 - a_1 = 1.415$, $a_3 - a_2 = 0.697$, were all greater than the yardstick, it is concluded that there was a definite difference in degree of liking between any two of the wines tasted.

One objection is made to the above form of scaling; no means is provided for determining the degree of liking for each individual wine. If, however, the scaling of Form 1 could be utilized, it would give a measure of how well a wine was liked. If the hypothesis of subtractivity is not invalidated, the difference between the numerical scores, for the two responses of the pair presented, could serve as a basis for an analysis of variance.

Table 6 gives the results from two-sample comparisons of the three Rosé wines (0, 1 and 3% sugar) using Form 1. The difference between scale values was used.

TABLE 6
Analysis of variance using Form No. 1 for paired comparisons of three Rosé wines

	Sum of squares	Degrees of freedom	Mean square
Main effects	1490.	2	745.***
Deviations from subtractivity	0.	1	0.
Average preferences	1490.	3	
Order effect	290.	3	97.***
Means	1780.	6	
Error	8862.	2124	4.2
Total	10642.	2130	

***p = less than 0.001.

TABLE 7
Analysis of variance using Form No. 1 for paired comparisons of three competitive table wines

	Sum of squares	Degrees of freedom	Mean square
Main effects	79.	2	39.5***
Deviations from subtractivity	0.	1	0.
Average preferences	79.	3	
Order effect	1678.	3	559.3***
Means	1757.	6	
Error	3771.	1278	2.95
Total	5528.	1284	

***p = less than 0.001.

obtained from the response to the two wines in each pair. The difference may vary from −8 to +8, as has been previously mentioned. A total of 2130 judgments was made, representing 355 in ecah order of presentation for the three two-sample comparisons. In the table it is noted that there are very highly significant main and order effects, while no deviations from subtractivity exist. The a's were calculated for each wine, which were $a_1 = -0.592$ for Rosé 0%, $a_2 = +0.001$ for Rosé 1% and $a_3 = +0.591$ for Rosé 3%. The "yardstick" $Y_{0.01}$ was calculated as before and found to be 0.183. Since this value for Y is much less than the difference between any two a's, the conclusion is that there are very highly significant differences in degree of liking between all three wines.

Another example of the analysis may be given to demonstrate the power of discrimination in tests of significance for differences in liking between wines. In two-sample comparisons three commercial, competitive table wines were served for preferences. These were a Sauterne, a Vin Rosé and a Red table wine, all containing 1% reducing sugar. The hedonic scoring of Form 1 and the difference between scores in paired comparison were used. Table 7 gives an analysis of variance from a total of 1284 judgments, 214 in each ordered comparison. Very highly significant main and order effects are noted with no deviations from subtractivity. Calculation of $Y_{0.01}$ yielded a value of 0.198. The *a* parameters were $a_1 = 0.190$ for the Sauterne, $a_2 = -0.035$ for the Vin Rosé and $a_3 = -0.155$ for the Red table wine. The differences in *a* values were as follows: $a_1 - a_2 = 0.225$, $a_1 - a_3 = 0.345$ and $a_2 - a_3 = 0.120$. It is evident that the preference of Sauterne over Vin Rosé is significant at about the 1% level, the preference of Sauterne over Red table wine is significant at much lower than 1% and that there is no significant preference between Vin Rosé and Red table wine. If the 0.1% level of significance is adopted as a practical working level, it would be concluded that there may be a definite preference for Sauterne over Red table wine, while no practical differences exist in the other comparisons.

The conclusions concerning the preferences were unaltered when the *t-test* was applied to the above data. The difference between the Sauterne and Red table wines was significant at the 0.1% level ($t = 3.52$), between Sauterne and Vin Rosé at the 5% level ($t = 2.23$) and between Vin Rosé and Red table wines the difference was not significant ($t = 1.11$).

CONCLUSIONS AND SUMMARY

Based upon the results of mass panel wine-preference studies during 1955 at two California fairs, a number of factors are discussed concerning the hedonic rating scales used.

There is a variable bias for the first sample served, ranging from 0.05-1.00 unit for the wines compared in this study. The degree of bias depends upon the wine comparison, the degree of difference in liking between wines and age of the individual.

Two types of correlation in two-sample comparisons are noted; one is the tendency for the taster to parallel his ratings for the two wines, and the other, a correlation arising from a shift in psychological reference standard due to some quality factor, such as sweetness. This latter observation raises the question whether two-sample comparisons or single sample presentations should be made to evaluate consumer acceptance since, in general, the consumer rarely compares two items side by side in the home.

A normal distribution of response freequencies is obtained by employing the difference between the two numerical values assigned to the hedonic scale for the two wines compared by each individual.

Also, the variance within sub-groups of age by frequency of use of wine becomes homogeneous when the differences are employed. Using the raw hedonic scores for each wine yields variances which vary with the mean.

Due to the nature of consumer preference and acceptance studies, a level of significance at 0.1% is recommended in order to minimize the error of the first kind.

An analysis of variance is gvien for paired comparisons which furnishes additional information other than the difference between mean scores.

Acknowledgment

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A Recording Strain Gage Denture Tenderometer for Foods. II. Studies on The Masticatory Force and Motion, and The Force-Penetration Relationship

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BASIC PRINCIPLES UNDERLYING the design of the recording strain gage denture tenderometer were implied in the first paper of this series *(1)* in which the initial tests and instrument evaluation were described. These basic principles may be summarized as: the biting and chewing (i.e., mastication) which a person exercises upon the food he eats reveal certain characteristics of the food to his subjective reactions. These characteristics, essentially subjective and variously designated by such terms as *tenderness, toughness, crispness, chewiness, soft, hard, crunchy*, etc., are important properties of food quality since they are intimately associated with the consumer's personal evaluation of the food. Frequently they are misinterpreted or overlooked by conventional physical, chemical, nutritional, or bacteriological quality evaluations.

The denture tenderometer was designed as an instrument which objectively measures some of these properties by simulating the denture surfaces and motions of chewing in the mouth. Quantitative measurements which are related to forces were sensitively and accurately recorded by a strain gage-oscilloscope arrangement.

An objective method of testing food quality cannot exclusively displace the subjective method, even if it succeeds in duplicating the mechanical aspects of the subjective test. The ultimate test of food quality always lies in consumer reaction, in spite of the difference in subjective evaluations between different people and even between acknowledged experts for a given sample of food. The difficulties involved in and the relative merits of the different methods for obtaining subjective evaluations have been discussed elsewhere *(2)*. The design of the denture tenderometer increases the probability of close correlation in the subjective-objective comparison. Nevertheless, subjective validation of each separate use of the denture tenderometer should be made. Only then can replacement of the objective test for the subjective yield results which are of use in quality evaluation.

Biological variations may manifest themselves as discernible differences to the consumer within even a small sample of a given food and such differences are of significance both qualitatively and quantitatively.

Before effective subjective validations for the numerous different applications are possible, it is necessary to apply knowledge of the masticatory functions involved, to insure greatest mechanical similarity between the subjective and objective tests. The literature in the field of dental research suggests those processes in human mastication which reveal to the subject the rheological[b] properties of the food undergoing the chewing process. Briefly, mastication consists of the process of biting and chewing food between the teeth by moving the lower jaw with respect to the upper jaw. The physiology and anatomy which make possible the complex movements which occur have been summarized by Klatsky and Fisher *(3)* and may be said to involve a unique arrangement of muscles in the head which allow articulation of the lower jaw with the bones of the head to which the lower jaw is attached. As a result the lower jaw may be depressed or elevated, and moved forward, backward, or sideward. The tongue, cheeks, and lips control and direct the food between the teeth. The tongue also feels the size of the particles of food and therefore relays information to the subject as to when the food should be swallowed. The saliva helps to soften and disintegrate the food in addition to its function as a carrier for digestive enzymes. The individual is informed of progress in the mastication process by sensory impulses originating both in the fleshy portions of the mouth and in the masticatory muscles. The different teeth which come into contact with the food perform various functions with varying degrees of efficiency in accordance with their structure (i.e., incisors, canines, bicuspids or molars). Therefore, the importance of tooth structure cannot be overlooked. In fact, the food habits of man are closely tied up with his tooth structure. "Man is an omnivorous animal. His teeth are adapted to a carnivorous, herbivorous, and frugovorous diet. He can pierce, incise, shear, and tear his food, as well as chew, comminute, grind and mill it." *(3)*.

These considerations led to the investigations reported herein. The action of the denture tenderometer has been studied in relation to teeth used and to movements and forces, as obtained for various settings of the instrument. By recording two variables simultaneously, dynamic demonstrations of the force-penetration relationships at all portions of the chewing cycle were examined.

APPARATUS

Strain Gage Denture Tenderometer. Modifications were made on the original instrument *(1)* to improve its operation and to adapt it for some of the uses described in this paper. Both the plate and filament batteries of the strain gage preamplifier were replaced by the stabilized power supply of the oscilloscope itself. In some of the force-penetration studies, the 6 volt bridge battery was changed to either 3 or 9 volts depending on whether decreased or increased sensitivity was desired in the force measurements.

[a] Contribution No. 294 from the Department of Food Technology, Massachusetts Institute of Technology.

[b] Rheology is the science of the deformation and flow of materials under various forces. The properties of interest here can therefore be termed rheological in nature.

Force-penetration apparatus. To obtain simultaneous indications of forces [c] and penetration into the food during the mastication process, the strain gage output was measured simultaneously with an output which was a function of the spacing between the dentures. This was accomplished by coupling a position transmitter (G. E. No. 8TJ9PDN) to the drive motor shaft. Figure 1 shows the arrangement of apparatus for this purpose. The position transmitter is a potentiometer which has a 360° tapped linear resistance. Double sliding contacts fixed 180° apart are attached to the continuously rotating shaft. Figure 2 shows how this arrangement is used for obtaining an

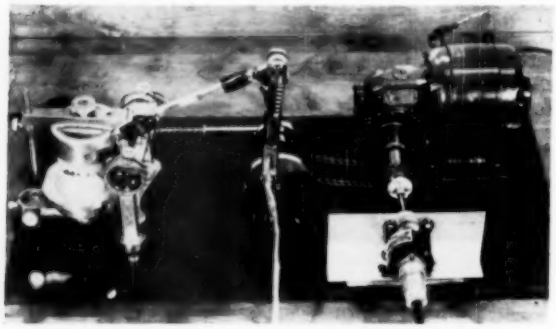

Figure 1. Strain Gage Denture Tenderometer showing dental articulator at left with mechanical drive linkages connecting it to the electric motor in the right rear. The position indicator for the horizontal coordinate of force-penetration diagrams is in the right foreground.

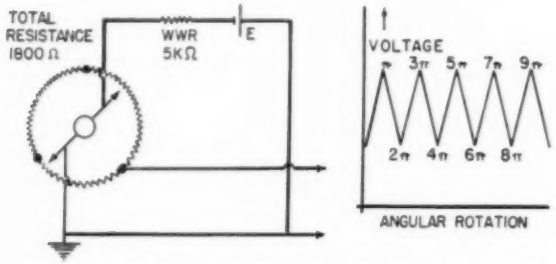

Figure 2. Electrical circuitry and sketch of output of position transmitter.

electrical output which is linearly related to the angular rotation of the shaft. The coupling may be made so that, for example, the minimum and maximum voltages appear simultaneously with minimum and maximum spacings between the dentures, respectively. The intermediate voltages then may be calibrated to indicate the various intermediate spacings between the dentures. Figure 3 shows three methods which were used successfully to simultaneously record the force and spacing (penetration) measurements. Figure 3(a) shows a dual channel amplifier-recorder (Sanborn Model 150) which produces the traces of the force and penetration outputs with respect to the time axis of a strip chart. This arrangement is very useful and convenient but requires a considerable financial investment in a dual channel recording device possessing sufficient speed and sensitivity to handle these signals.

Figure 3(b) shows how the two signals may be used to actuate both the horizontal and vertical deflections of the electron beam on the face of an oscilloscope cathode ray tube. The resultant trace is an automatic X-Y plot of the force and penetration. This arrangement has the great advantage of producing a graphical plot of the force-penetration relationship throughout the entire chewing cycle. Figure 4 shows how the completed cycle of a single bite will appear if the trace on the face of the cathode ray tube is photographed. However, the recording of succeeding bites requires the use of a method for photographing each bite on separate films as they appear, inasmuch as succeeding cycles on the same film may superimpose and not be distinguishable.

[c] Forces denoted here refer to the resistances offered by the food to the teeth motion. They are measured by the strain gage output and are analogous to the sensory impulses produced in the masticatory muscles.

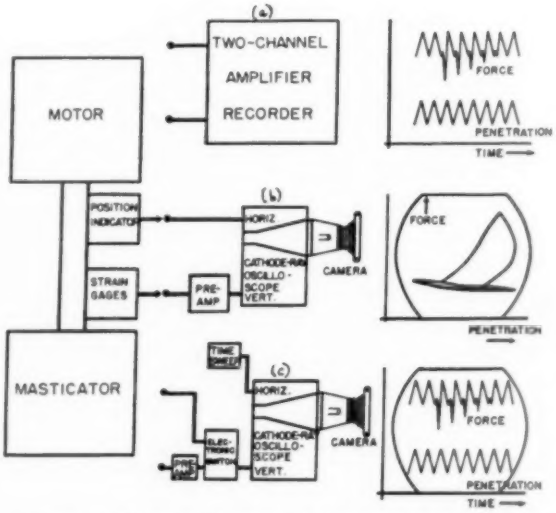

Figure 3. Schematic diagrams of three methods of obtaining force-penetration relationships.

Figure 3(c) shows how the oscilloscope may be used to measure both the force and penetration signals as vertical deflections whereas the horizontal deflection is a function of time. The traces photographed on the cathode ray tube are similar to those obtained on the strip chart of a dual channel recorder. This result is achieved by means of an electronic switch (Heathkit Model S-2) which feeds both signals alternately into the vertical deflection circuit of the oscilloscope by switching between them rapidly in succession. The electronic switch also allows the two signals to be inserted at different potentials so that they are separated on the face of the cathode ray tube. The two signals are thus simultaneously, but separately, recorded as vertical deflections.

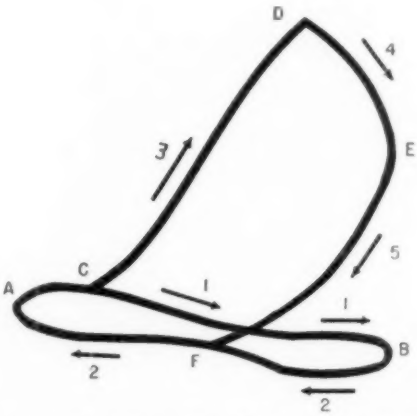

Figure 4. Force-penetration diagram obtained by using strain gage output as vertical input and position indicator output as horizontal input to oscilloscope. AB (1 and 2) = free run; C = point of initial contact with sample; 3 = "bite-down" to D = point of maximum deflection; 4 = "bite-down" to E = point of maximum penetration; 5 = "bite-up" to F = loss of contact with food.

EXPERIMENTAL METHODS

Force and motion studies. These studies were undertaken to obtain information necessary for simulation of the characteristic movements needed for individual food studies. The masticatory portion of the Strain Gage Denture Tenderometer is a modified commercial dental articulator with a variety of adjustable guides to allow changes in mandibular movements. Changes in movements include variations of maximum and minimum openings between the teeth and variations in sideward and front-to-rear displacements. Distances on the left first-molars were measured with calipers to obtain vertical and front-to-rear displacements directly, and impressions in a soft wax (Apiezon "Q") were used to obtain sideward displacements.

Measurements were made on combinations of interest. Preliminary studies had indicated which settings were practical for use in tests; in some cases, for example, the teeth did not come together sufficiently to chew on the sample, and in other cases, the upper and lower teeth contacted, recording the force of tooth against tooth rather than of tooth against sample.

To determine effect on force measurement on a sample for different settings, a one cubic centimeter sponge rubber cube was used as a standard resistance. The cube was placed between the molars while the teeth were in motion, and the trace was photographed. Pictures were taken for each group of settings and deflections were measured. The possibility existed that the sponge rubber cube was non-isotropic (i.e., exhibits different characteristics along different axes) and therefore would yield variable results arising from its own characteristics, rather than from the movements of the articulator. Tests were therefore carried out with the orientation of the cube for a constant setting being varied. The results indicated no detectable differences and the standard cube was assumed to be isotropic as far as these tests were concerned.

The results obtained from these studies indicated the effect of different condylar and lateral adjustment settings on the movements and forces exerted on a given sample and suggested optimum settings to be used in future work on various foods.

In the studies involving the effect of the position of the teeth in the mouth, the sponge rubber cube was placed between the different opposing pairs of teeth, and maximum deflections were recorded for each pair, using a constant setting of adjustments. This procedure was then repeated for different adjustment settings.

Force penetration studies. The instrument was set up as in Figure 3(b) and the oscilloscope was adjusted so that the total horizontal deflection filled the horizontal distance on the screen. The vertical sensitivity was kept at similar settings to those used in previous studies. The detailed action of a single bite is illustrated in Figure 4.[4] After a one bite cycle, with no food, the sample of food was placed between the left first molars and the masticator allowed to go through an additional bite cycle. The oscillogram showed the force-penetration cycles with food and without food.

The samples selected for these first force-penetration analyses are common foods which possess rheological properties readily detected by the consuming public during mastication; potatoes, apples, pears, meat, peas, candy bars, carrots, cheese, almonds, celery, and hard boiled eggs were used.

The samples of food were cut from representative volumes into cubes the sizes of which were reasonably matched with those ordinarily chewed in the mouth.

[4] The path from E to F (bite-up curve) does not involve an abrupt drop to zero because the food exerts force on the teeth until actual loss of contact at F. This force, which is exerted on the teeth *while they are opening*, is not negligible for most foods.

RESULTS AND DISCUSSION

Adjustments for displacement and force variations. Variations in the detailed motion of the articulator were experimentally obtained by variation of the condylar and lateral adjustment settings. A portion of these data is given in Table 1. The vertical distances between the left first molars at minimum spacing of the teeth and also the forward-rear and sideward components of relative motion of the same teeth are given. These data illustrate the large diversity in movements that is possible. It is to be noted also that the relative force recorded with the test object varies over a considerable range with the variation in movement.

Force exerted as a function of tooth position. At any particular setting of adjustments, the entire denture moves as a unit. Different relative movements will be imparted to different teeth in the denture depending upon their positions. Furthermore, because of the different areas and shapes of the surfaces on the different teeth, the recorded forces on a standard test

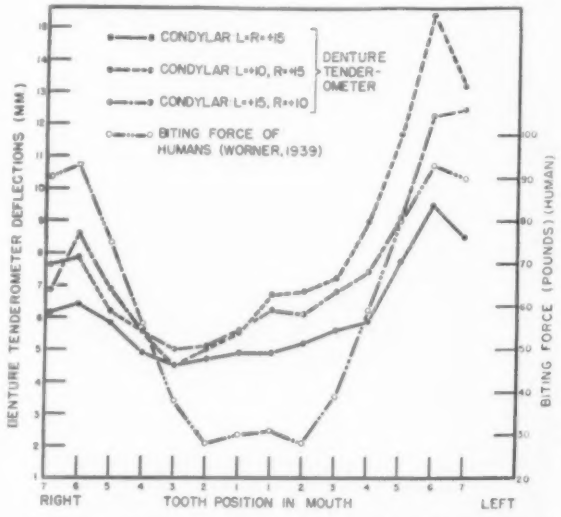

Figure 5. Curves showing effect of varying the position of placement in the denture of a standard sponge rubber cube; also given is a curve showing the maximum average biting force of the various tooth pairs in the human mouth.

TABLE 1

Effect of condylar and lateral adjustment settings on force and motion
A. Sideward displacement; B. Forward displacement; C. Minimum vertical spacing between teeth; D. Relative force (mm. deflection); G. Tooth surfaces touch

Condylar adjustment: Left		0				+10				+15				+15			
		+10				+10				+10				+15			
Lateral adjustment		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Left	Right																
0	0	4.5 mm.	2.0 mm.	G	—	3.0 mm.	2.0 mm.	1.0 mm.	12.3 mm.	2.0 mm.	2.0 mm.	1.5 mm.	7.3 mm.	2.5 mm.	2.0 mm.	2.0 mm.	6.3 mm.
0	10	3.5	2.0	G	—	3.0	1.0	1.0	16.2	2.0	1.0	1.5	7.3	2.5	1.5	2.0	6.3
10	0	4.0	2.0	G	—	3.0	2.0	1.0	14.5	3.0	2.0	1.5	7.8	2.0	1.5	2.5	5.0
10	10	4.0	2.0	G	—	3.0	1.5	1.0	14.7	3.0	1.5	2.0	8.3	2.0	1.5	2.0	5.8

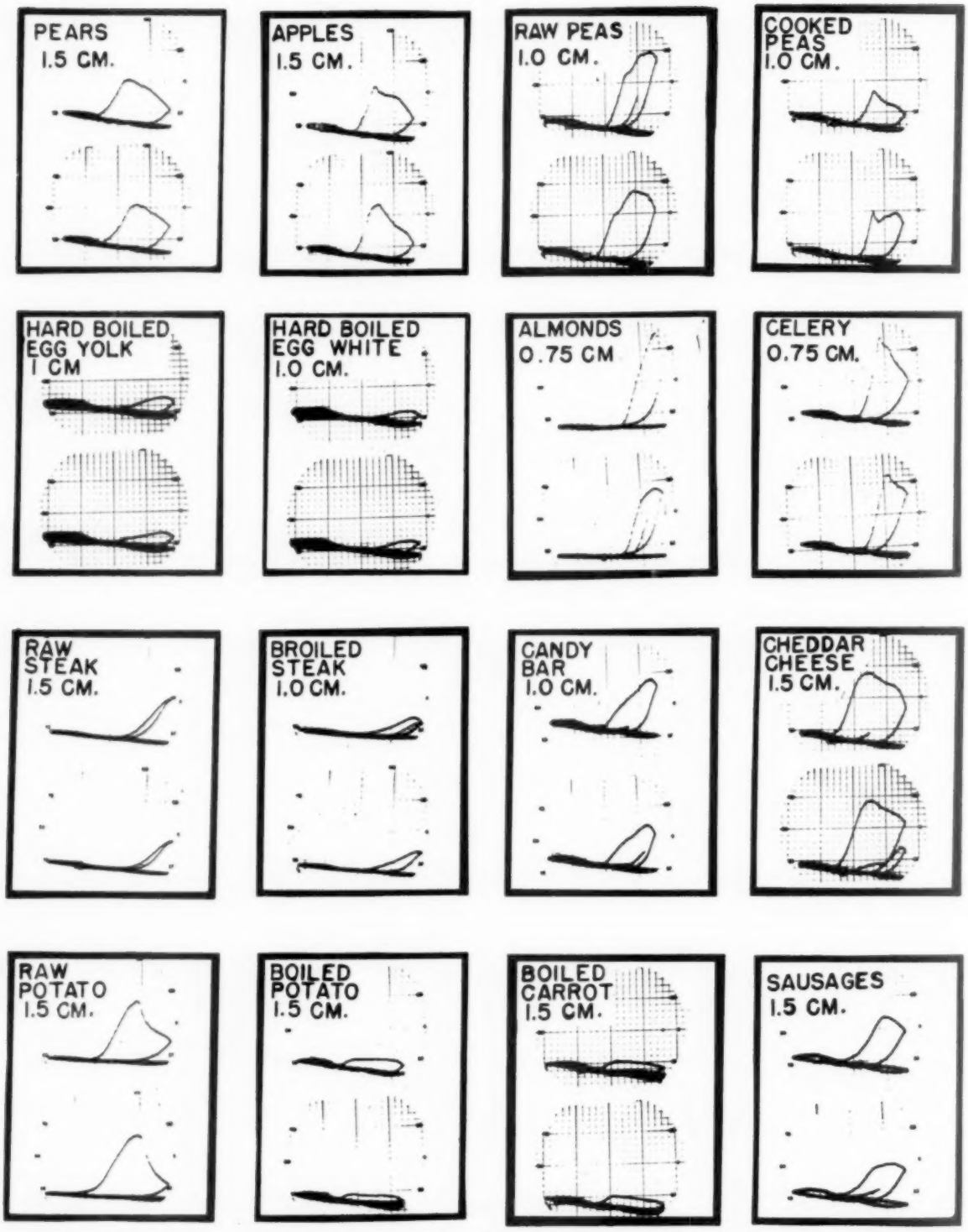

Figure 6. Force-penetration oscillograms of representative foods. The measurements in cm. indicate the size of the sample used in each test.

object will vary with the particular pair of teeth used. Figure 5 shows the various recorded deflections obtained by placing the standard sponge rubber cube between all possible pairs of opposing teeth. For a given condylar setting, the distinct variation in recorded deflection as a function of tooth position is apparent. The overall variation for a change in condylar setting is also evident. The larger deflections obtained on the left side as compared to the right side arise because of the direction of sideward displacement of the opposing teeth which remained constant throughout the experiment. Sideward motion on the downward bite was toward the outer cusps* of the bottom teeth on the right side whereas it was toward the inside cusps on the bottom teeth on the left side. Also shown in Figure 5 is a curve which gives the average maximum biting forces, as recorded by Worner *(4)*, of two Australian dental students (21 and 23 years old) whose teeth were in good condition. Although these curves arise from different sources(in the case of the tenderometer, deflection depends upon the resistance of the object to a force and is not a maximum force exerted), they are somewhat similar in shape. Manly *(5)* points out that platform or biting surface area is a considerable source of the variation of maximum force with tooth position. Since tooth platform area is the common feature of the two experiments, the curves support the importance of dependence of biting force on platform area.

Force-penetration analyses. Figure 6 shows the dynamic force-penetration oscillograms obtained for several different types of food. The oscillograms are representative of the particular samples which were used. For comparison of amplitudes, samples of the same size should be normalized to the same sensitivity (obtained from free run) *(1)*. Different samples of a given food may differ widely in mastication characteristics and therefore may give differently shaped force-penetration relationships. These diagrams, however, can be useful for recognizing, measuring, and defining many properties which have never been adequately measured or even precisely defined.

These diagrams may be analyzed in the following way.

1. Measurement should be made on the "bite-down" curve. The angle of ascent to maximum force (or any unique shape or characteristic if this ascent is non-linear), the maximum force and the distance of penetration at which the maximum force appears should be measured. The angle of "bite-through" following maximum force to the point of maximum penetration (or any unique shape or characteristic of this portion of the curve, if non-linear) should also be measured.

2. The significance of the "bite-up" curve (which represents the force exerted against the teeth when the mouth is opening) is possibly not as great as the bite-down curve and its variability is considerable because of the fact that the food has already been broken up. However, in certain applications, these characteristics should be observed. The area bounded by the two curves is an indication of the change which has occurred in the food.

3. Measurements should be normalized to correspond to differences resulting from size of sample and/or overall sensitivity. Investigations of rheological properties in terms of these measurements are being conducted at the present time in these laboratories and will be reported at a future date.

For illustrative purposes, a particular example is here considered. A "crisp" food requires an appreciable initial mastication force to break through the food, but once such a break-through is achieved, the force necessary to complete the bite is noticeably diminished. The oscillogram for celery (Figure 6) shows a steep rise of force to a maximum, and then a sharp decrease to the point of maximum penetration. The oscillogram of celery thus suggests properties which apparently correspond to the subjective interpretation of "crispness."

CONCLUSIONS

The denture tenderometer by virtue of its mechanical movements, denture surfaces and sensitive methods of force measurement can measure significant properties of small samples of food. The force-penetration analysis of the individual bite in the denture tenderometer and the ability to use different pairs of opposing teeth in the bite enable the specific chewing habits of the human being for the particular food under investigation to be approached and therefore subjective reactions in the chewing process can be estimated.

Acknowledgment

The authors wish to express their gratitude to those who have aided in the research resulting in the material presented in this paper. These include Miss May Welch for her technical asistance in obtaining the data for Figure 5, the Library of the American Dental Association, Chicago, Illinois, for the loan of extensive material on mastication, and W. M. Murray of the Department of Mechanical Engineering, M. I. T., for his loan of a multichannel amplifier-recorder for some of the force-penetration studies.

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* A cusp is a pointed vertical projection on the grinding surface of a tooth.

Factors Influencing the Color of Potato Chips[a, b]

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IN AN ATTEMPT to reveal the relation between the chemical composition of potatoes and the color of the chips produced therefrom, a group of investigators reached the following conclusions. Sweetman *(18)* concluded that there is an increase in the brown color of the chips corresponding to an increase in the total sugar content of the tubers. The same correlation was also established by Rogers and coworkers *(13)* who demonstrated that potatoes stored under different conditions vary greatly in their sugar content and that this factor is an important one influencing browning of potato chips. Thornton *(19)* stated that at the temperature used in making potato chips, only reducing sugars content, not that of sucrose, was responsible for the brown color of the chips. Wright *et al. (22)* believed that reducing sugars greatly affect the color of the chips, yet their effect seems to be complicated by certain amino nitrogen compounds present in varying concentrations in the different varieties of potatoes. Legault and coworkers *(10)* found that browning of potatoes is due in part at least to a Maillard type of reaction between reducing sugars and amino acids. Shallenberger *(17)* using model systems to study the chemical nature of potato chip color concluded that the sugar concentrations to be found in potatoes did not cause any color development when heated alone. When the sugars were heated with glycine, representing the total nitrogen of the potato tubers, it was found that although color developed, it fell short of the actual color intensity induced by frying potatoes for chips. It has been stated that higher specific gravity is associated with a higher yield of potato chips per hundred pounds of raw stock *(7, 8, 20)*. It has also been indicated that specific gravity of raw potatoes is a reliable index for the color of the chips produced therefrom *(1, 7, 9, 17, 21, 23)*. However, this conclusion has not been sustained by some authors *(3)*.

The storage temperatures for potatoes to be used for chipping have a pronounced effect on the reducing sugar content. Numerous papers have been published on the effect of different storage temperatures on the rate and extent of sugar accumulation *(2, 4, 5, 15, 24)*. Wright *(25)* indicated that, in general, 40° F. is the most satisfactory temperature for long storage since at this temperature sprouting would not begin before 6 to 8 months. Although potatoes taken directly from storage at this temperature cannot be used for chips, the suitable varieties can be de-sugared or conditioned in 2 to 3 weeks. The rate at which reducing sugars disappear during conditioning depends upon the variety, the length and temperature of previous storage, and the temperature during curing *(6, 12)*. Ross *(14)* reported that the rate of de-sugaring is much faster at 70° F. than at lower temperatures, but only slightly more rapid at 80° F. than at 70° F.

Very little information is available concerning the changes in the amino nitrogen contents of potato tubers during either storage or conditioning. The main objective of the investigation reported herein was to evaluate some of the chemical and physical factors that influence the color of potato chips.

EXPERIMENTAL

Four varieties were included in this study; namely, Katahdin and Russet Rural (two varieties with high specific gravity) and Red Kote and Red Pontiac (varieties with low specific gravity). The potatoes from the Ohio Agricultural Experiment Station plots at Wooster, Ohio, were harvested when they reached maturity. Potatoes of each variety were divided into 5 lots, one chipped and analyzed immediately as soon as harvested. The other 4 lots were stored at 40° F. for 4 weeks. At the end of this period the potatoes of all 4 lots were removed from the cold storage and samples were taken from one lot for frying and analysis. The remaining 3 lots were stored at approximately 75° F. for conditioning. At the end of 2, 3, and 4 weeks, at 75° F. one lot was taken for frying and analysis. In each particular case, 2 replicates from each lot were taken and each replicate was duplicated. Each replicate consisted of 10 pounds of potatoes taken at random. Thus, data were collected to indicate changes that take place during storage at 40° F. and at the end of three intervals of conditioning (2, 3, and 4 weeks) respectively.

The following analysis were made on the raw potatoes:

Specific gravity; this was measured by the potato hydrometer developed and calibrated by the National Potato Chip Institute, Cleveland, Ohio.

Total solids content by the oven drying method.

Reducing sugar content by the Shaffer-Hartman method *(16)*.

Free amino nitrogen content using the Van-Slyke microapparatus and following the procedure described by Morrow *(11)*.

The last two tests were run on alcohol extracts of raw potatoes. The latter were prepared by extracting the raw potatoes with 80% alcohol in ordinary soxhlet extractors for 22 hours.

Frying technique. The potatoes were peeled in a Reynolds rotary-type abrasive vegetable peeler. They were then halved (longitudinally) and sliced in a rotary-type, hand-operated slicer. The slicer blade was previously set so a slice of approximately $^{3}/_{64}$ inch was produced. While slicing, the cut sections were allowed to drop into a pan of cold (Columbus soft) tap water placed below the slicer. The potato slices were then agitated thoroughly to remove loose starch. The water was drained and the slices removed to another pan of cold water and agitated again for a couple of minutes. The slices were then spread on a dry clean towel for 3 minutes to remove excess moisture. A thermostatically-controlled french fryer of the type commonly employed in restaurants was used in frying. The thermostat was set at 375° F. As soon as the temperature of the frying reached this temperature, as shown by a light indicator, the temperature was double checked by means of a mercury thermometer. The heating unit was then turned off and the potato slices were immersed in the frying fat (Primex). The end point was determined by cessation of bubbling. The chips were then drained and packed in cellophane bags and sealed.

Color measurement.

A. The Hunter Color and Color Difference Determination

The color of the potato chips was measured objectively using the Hunter Color and Color Difference-meter. It was necessary

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 14, 1955.

[b] Journal Article No. 24-56, Ohio Agricultural Experiment Station, Project: Hatch 122-3.

to get a homogenous mixture that would be truly representative of the entire sample. All chips in any one sample were not identical and to pick an average-colored chip would have been a difficult task and would have introduced a certain amount of subjectiveness into the method. Thus, a sample of approximately 40 g. was ground in an Osterizer. The grinding was continued until a mixture homogenous in texture and color was obtained. Approximately 5 minutes were required to grind each sample to have an appearance similar to corn meal. This was done directly before measuring the color in the "Hunter" instrument. The ground sample was then placed in a viewing cell 3½ inches high and 2 inches in diameter with a bottom of optically clear glass. The cell containing the mixture was then tapped squarely and lightly on a padded table top until the chip sample filled the cell to a height of about 3 inches. The sample was then read on the "Hunter" instrument. Circuits of the color difference meter were initially balanced with an especially prepared ceramic tile, ivory in color, a color which was the nearest to that of light color potato chips. The circuit L, a_L and b_L was used in balancing the instrument with the standard tile and then color specifications of the experimental samples were read directly and recorded in terms of L, a_L and b_L. The values for this standard color for the L color scales are as follows:

L = plus 73.4, a_L = plus 1.00 and b_L = plus 31.7.

B. Spectrophotometric Measurement of the Pigments Extracted from Potato Chips

The fat was extracted from the chips to be used in spectrophotometric determination with dry ether for 12 hours. The samples were dried and the pigments were then extracted with 50:50 by volume ethyl alcohol: water solution. The extraction was accomplished by boiling in hot water bath for 15 minutes. The extracts were then filtered and made up to a standard volume with the alcohol-water solution. Aliquots of the filter extracts were then measured in the Beckman DU spectrophotometer at a wave-length of 390 mμ.

RESULTS

Specific gravity determination. Results showing the effect of storage at 40° F. followed by conditioning at 75° F. are presented in Table 1. There were significant

TABLE 1

Effects of storage and conditioning on the specific gravity of raw potatoes (as determined by the potato hydrometer)

Treatments	Varieties				
	Katahdin	Red Kote	Red Pontiac	Russet Rural	Mean
Before storage at 40° F.	1.071	1.066	1.061	1.074	1.068
After storage at 40° F.	1.073	1.062	1.060	1.077	1.068
Two weeks of conditioning	1.075	1.065	1.062	1.079	1.070
Three weeks of conditioning	1.076	1.065	1.065	1.080	1.071
Four weeks of conditioning	1.077	1.065	1.065	1.075	1.070
Mean	1.074	1.064	1.062	1.077	

L S D at the 1% level: between varieties = 0.002
between storage and conditioning treatments = 0.001

differences in specific gravity between all the varieties included in this investigation. However, although the differences were sginificant between Russet Rural and Katahdin, and between Red Kote and Red Pontiac, the differences were relatively low compared to the differences between either Russet Rural and Red Kote, or between Russet Rural and Red Pontiac.

There were significant differences in specific gravity before and after storage at 40° F. When potatoes were placed at 75° F. for conditioning, the specific gravity increased significantly with the increasing length of the conditioning period until it reaced a peak at the end of 3 weeks of conditioning after which it started to decrease. With three of the four varieties, however, the specific gravity was significantly higher after 3 weeks of conditioning than it was before storage.

Total solids determination. Results of the total solids determinations are shown in Table 2. As in the case with specific gravity, the two varieties Katahdin and Russet Rural showed significantly higher contents of total solids as compared to Red Kote and Red Pontiac (before storage Red Kote had a slightly though not significantly higher content of total solids than Katahdin). The total solids content decreased during storage at 40° F. but the differences were not significant except in the case of Red Kote where the difference was signifi-

TABLE 2

The effects of storage and conditioning on the total solids content of raw potatoes (percent)

Treatments	Varieties				
	Katahdin	Red Kote	Red Pontiac	Russet Rural	Mean
	%	%	%	%	%
Before storage at 40° F.	20.36	20.39	17.56	22.28	20.16
After storage at 40° F.	21.29	17.62	17.21	23.10	19.80
Two weeks of conditioning	22.53	19.74	17.91	23.10	20.82
Three weeks of conditioning	22.91	19.82	19.61	24.16	21.62
Four weeks of conditioning	23.06	20.36	19.64	22.34	21.37
Mean	22.93	19.57	18.39	23.04	

L S D at the 1% level: between varieties = 1.02
between storage and conditioning treatments = 1.02

cant. Total solids content in general became higher with increasing length of conditioning period, with the maximum usually reached in three weeks.

Reducing sugars determination. The effects of storage at 40° F. followed by conditioning at 75° F. are presented in Table 3. In general there were significant differences between the reducing sugar contents of all varieties. The varieties could be arranged in the following decreasing order with respect to their content of reducing sugars; Red Pontiac, Red Kote, Katahdin then Russet Rural. The two varieties Red Kote and Red Pontiac, contained significantly higher amounts of reducing sugars than varieties Katahdin and Russet Rural. Although Russet Rural and Katahdin showed significant differences in their reducing sugar contents

TABLE 3

The effects of storage and conditioning on the reducing sugar contents of raw potatoes in percent dry weight basis

Treatments	Varieties				
	Katahdin	Red Kote	Red Pontiac	Russet Rural	Mean
	%	%	%	%	%
Before storage at 40° F.	0.45	0.73	0.83	0.42	0.60
After storage at 40° F.	1.31	1.48	1.69	1.18	1.39
Two weeks of conditioning	0.47	0.64	0.71	0.23	0.51
Three weeks of conditioning	0.25	0.47	0.60	0.07	0.34
Four weeks of conditioning	0.08	0.32	0.39	0.04	0.20
Mean	0.51	0.73	0.83	0.39	

L S D at the 1% level: between varieties = 0.05
between storage and conditioning treatments = 0.05

the difference was of a relatively lower magnitude compared to that between either of these two varieties and Red Kote or between any of them and Red Pontiac. However, all varieties accumulated very high amounts of reducing sugars during cold storage which decreased significantly during conditioning. In this respect lowest values of reducing sugars were obtained at the end of 4 weeks of conditioning. Moreover, the reducing sugars contents for all varieties were significantly lower at the end of 3 weeks of conditioning than before storage.

Free amino nitrogen determination. Results for the free amino nitrogen determination (Table 4) indicate no significant differences in the free amino nitrogen content among the 3 varieties Russet Rural, Red Kote, and Katahdin. There were significant differences, however, between any of the aforementioned varieties and Red Pontiac; the latter variety having higher contents. Moreover, the two varieties, Red Kote and Red Pontiac, which had practically identical specific gravity and comparable reducing sugar contents, differed significantly in their contents of free amino nitrogen.

There were no significant changes in the free amino nitrogen content of all varieties due to storage at 40° F. During conditioning at 75° F. however, the free amino nitrogen contents decreased significantly until they reached the minimum level at the end of 3 weeks of conditioning, after which, they started to increase. The free amino nitrogen content was significantly lower at the end of 2 and 3 weeks of conditioning than before storage. Although there was a significant increase in the free amino nitrogen content during the fourth week of conditioning, yet the values at that time of conditioning were still significantly lower than the values obtained before storage.

TABLE 4
Effects of storage and conditioning on the free amino nitrogen contents of raw potatoes in percent dry weight basis

Treatments	Varieties				
	Katahdin	Red Kote	Red Pontiac	Russet Rural	Mean
	%	%	%	%	%
Before storage at 40° F.	0.37	0.38	0.52	0.38	0.41
After storage at 40° F.	0.42	0.40	0.54	0.37	0.43
Two weeks of conditioning	0.14	0.11	0.32	0.10	0.16
Three weeks of conditioning	0.07	0.02	0.15	0.04	0.07
Four weeks of conditioning	0.16	0.13	0.30	0.15	0.21
Mean	0.23	0.21	0.37	0.21	

L S D at the 1% level: between varieties = 0.11
between storage and conditioning treatments = 0.11

Color determination of potato chips.

A. Objective Color Evaluation with the Hunter Color and Color Difference Meter

In this study, the Hunter "L" readings showed large variations while the other two readings a_L and b_L showed little variations with a_L readings showing a maximum of +12.5 and a minimum of +2.0 and b_L a maximum of +22.7 and a minimum of +10.1. Thus, in the results to be presented later to show the effects of storage and conditioning on the color of potato chips in Table 5, the "Hunter" L readings are reported as representatives for color. Furthermore, these readings were also used in correlating the various characteristics of raw potatoes with the color of the chips.

In general, the data obtained indicate no significant differences between the 3 varieties—Katahdin, Red Kote, and Russet Rural—presented as Hunter "L" readings. (The higher the "L" reading the brighter and more acceptable the color of the chips.) There were significant differences, however, between the color of the chips produced from any of these varieties and those produced from the Red Pontiac variety.

The Hunter "L" readings of the potato chips produced from all varieties immediately after storage were significantly lower than those readings obtained before storage. All varieties at this time produced dark colored unacceptable chips. After two weeks of conditioning, the Hunter "L" readings were not significantly lower than those produced before storage but were significantly higher than the readings obtained when potatoes were fried immeditely after cold storage. However, the Hunter "L" readings increased in value, i.e. the color of the chips became brighter with the increasing length of the conditioning period. The highest "L" readings were obtained when potatoes were fried after four weeks of conditioning. These values were not significantly higher, however, than those obtained from chips made after three weeks of conditioning. Note, however, that after two weeks of reconditioning that the Russet Rural tubers produced good colored chips whereas it required three weeks for the Katahdin and Red Kote varieties, and no desirable chips could be made from Pontiac tubers even after four weeks of reconditioning.

B. Spectrophotometric Determination

The results are expressed as optical density of the extracted pigments in Table 6. As was the case with the Hunter "L" readings the data indicate no significant differences in the pigment concentration between the three varieties Katahdin, Red Kote, and Russet Rural. The differences were significant, nevertheless, between the pigment concentration of these 3 varieties and the pigment concentration of the Red Pontiac variety. Comparing the two varieties Russet Rural and Red Kote, it is noted that although Red Kote is a low specific gravity variety and having a significantly higher reducing sugar

TABLE 5
Effects of storage and conditioning on the color (Hunter L readings) of potato chips fried at 375° F.

Treatments	Varieties				
	Katahdin	Red Kote	Red Pontiac	Russet Rural	Mean
Before storage at 40° F.	53.4	52.7	44.2	51.0	50.3
After storage at 40° F.	32.6	37.7	26.0	31.0	31.8
Two weeks of conditioning	45.7	47.4	37.6	63.5	48.5
Three weeks of conditioning	60.3	61.1	38.0	63.6	55.8
Four weeks of conditioning	63.7	62.0	47.2	58.8	57.9
Mean	51.5	52.1	38.6	53.5	

L S D at the 1% level: between varieties = 6.2
between storage and conditioning treatments = 5.4

TABLE 6
Effects of storage and conditioning on the optical density of extracted pigments of potato chips fried at 375° F.

Treatments	Varieties				
	Katahdin	Red Kote	Red Pontiac	Russet Rural	Mean
Before storage at 40° F.	0.48	0.48	0.61	0.52	0.52
After storage at 40° F.	0.89	0.75	1.17	0.95	0.94
Two weeks of conditioning	0.55	0.57	0.75	0.36	0.55
Three weeks of conditioning	0.39	0.39	0.74	0.36	0.47
Four weeks of conditioning	0.36	0.38	0.57	0.41	0.43
Mean	0.53	0.51	0.72	0.52	

L S D at the 1% level: between varieties = 0.10
between storage and conditioning treatments = 0.09

content than the Russet Rural variety, the two produced on the average, practically identical concentrations of the coloring pigments. In this respect it is noticed that the two varieties did not show any significant differences in their free amino nitrogen contents which may be the limiting factor in the pigments producing reactions. The above observations hold true when comparing the two varieties Katahdin and Red Kote. Moreover, the two varieties Red Kote and Red Pontiac that have low specific gravities could be considered, practically speaking, as having identical reducing sugar contents. Nevertheless, Red Pontiac having significantly higher free amino nitrogen content produced significantly more pigment concentration than Red Kote.

However, when potatoes were fried immediately after cold storage the pigments resulting from frying were produced in large concentrations and the chips acquired a dark brown color. When potatoes were stored at 75° F. for conditioning the reducing sugars and free amino nitrogen decreased and likewise, the pigments resulting from frying decreased with the increasing length of the conditioning period until they reached the minimum at the end of 4 weeks of conditioning. The concentration of the coloring pigments was lower at the end of 3 and 4 weeks of conditioning than before storage.

DISCUSSION

When the results of the spectrophotometric determination were correlated with the Hunter "L" reading a correlation coefficient of −0.97 was obtained. The correlation coefficient is significant at the 1% level and well above the 0.80 minimum value used for prediction purposes. This indicates the validity of the Hunter "L" readings in predicting the relative concentrations of the pigments resulting from frying.

TABLE 7
Correlation of various characteristics of raw potatoes to the color of potato chips

Characteristics correlated	Correlation coefficient ("L" values)	Coefficient of determination (% values)
Hunter "L" readings vs. optical density of extracted pigments	−0.97*	94.1
Hunter "L" readings vs. specific gravity of raw potatoes	+0.53*	28.1
Hunter "L" readings vs. total solids % of raw potatoes	+0.52*	27.0
Hunter "L" readings vs. reducing sugars % of raw potatoes	−0.85*	72.3
Optical density of extracted pigments vs. reducing sugars % of raw potatoes	+0.89*	79.2
Hunter "L" readings vs. free amino nitrogen % of raw potatoes	−0.72*	51.8
Optical density of extracted pigments vs. free amino nitrogen % of raw potatoes	+0.68*	46.2

* Significant at the 1% level.

Specific gravity. High specific gravity has long been considered by potato chippers as a criterion for the suitability of various potato varieties for frying. The data obtained in this study which included a variety Red Kote known to have a low specific gravity yet producing good chips, indicate that difference in specific gravity between varieties could not always be relied upon to indicate chipping possibilities. The correlation coefficient (+0.53) obtained when correlating the Hunter "L" readings of the chips vs. the specific gravity of the raw potatoes was considerably below the 0.80 minimum value used for prediction purposes. This evidence further indicates that the usefulness of specific gravity of potato tubers as an index of chipping quality is limited.

Reducing sugars. The correlation coefficients obtained upon correlating the reducing sugar contents of raw potatoes vs. the Hunter "L" readings (−0.85) and vs. the optical density of the pigments extracted from the chips (+0.89) were significant at the 1% level and above the 0.80 minimum value used for prediction purposes. The results in both cases indicate the utmost importance of the reducing sugars in color production in the chips. Moreover, in general, the reducing sugar contents of raw potatoes would be reliable indices for predicting the color of the chips to be produced. In spite of this, some varietal differences indicate trends which were not in agreement with the above correlation. Thus, Red Kote and Russet Rural, the two varieties which showed significant differences in the reducing sugar contents, produced chips that were of good color. The difference between Red Kote and Red Pontiac in reducing sugar content, although significant, was not of such value as to account for the highly significant differences in the color of the chips produced from these two varieties.

Free amino nitrogen. The correlation coefficient (−0.72 and +0.68) obtained when correlating the free amino nitrogen contents of raw potatoes vs. either Hunter "L" readings or the optical density of the extracted pigments, was in both cases significant at the 1% level but below the 0.80 minimum value used for prediction purposes. This indicates that in general the free amino nitrogen contents cannot be used as a valid means of predicting the color of the chips. They, nevertheless, play a relatively important role in the color producing reactions. Their importance is evident in the differences indicated between various varieties. If, for instance, prediction would be based on reducing sugar content alone, Russet Rural and Katahdin would be expected to produce light colored chips while Red Kote would fail to do so. This was not the case, as the 3 varieties produced chips of essentially the same color. These varieties did not show any significant differences in their content of free amino nitrogen. An analysis of the two varieties, Red Kote and Red Pontiac, provide more evidence on the role of amino nitrogen in color development in the chips. The differences in reducing sugars were not high enough to account for the differences in

the color of the chips. On the other hand, the two varieties differed significantly in their contents of free amino nitrogen. Red Pontiac with a high content of free amino nitrogen produced dark colored chips. These data would indicate that the free amino nitrogen may be in some cases a limiting factor in the color producing reactions and thus should be considered when judging any variety for chipping.

Storage and conditioning. Storage and conditioning of potato tubers influence the color of potato chips made therefrom by virtue of their effects on the quantities of the color producing reactants in the tubers. The total solids contents after storage at 40° F. was slightly less than before storage but the difference was not significant. When potatoes were held at 75° F. for conditioning the total solids contents increased with the increasing length of the conditioning period, until they reached a maximum after 3 weeks. Analysis of the data indicated a negative correlation between total solids and reducing sugars of −0.60. There was also a negative correlation between the total solids and free amino nitrogen of −0.47. The two values were significant at the 1% level. Regardless of their small value for prediction purposes they indicate that as the total solids became higher there was a decrease in reducing sugars and free amino nitrogen.

A multiple correlation was calculated to correlate the effects of total solids, reducing sugars and free amino nitrogen contents of raw potatoes vs. the color of the chips. The correlation coefficient obtained was 0.87. Reducing sugars, free amino nitrogen, and total solids contents when correlated separately with the color of the chips gave the correlation coefficients, −0.85, −0.72 and +0.52, respectively. Thus the prediction that could be made by a multiple correlation which includes the three variables would be slightly better than the correlation involving the reducing sugars and color only. However, the magnitude of the reducing sugar correlation, −0.85, adds more evidence to the importance of reducing sugars in color formation. However, the correlation coefficient of free amino nitrogen vs. color was also of considerable importance. Thus, although free amino nitrogen contents would not be valid for prediction purposes, they do play a relatively important role in the color producing reactions. In other words, although reducing sugars are the most important factor determining the color of the chips, their importance in some cases may be limited by the relative amount of free amino nitrogen and hence both factors must be considered when evaluating any variety for chipping. Finally, it must be mentioned that the varieties chosen for this study were those known to differ widely for the attributes studied. Moreover, the results obtained were for one year only and, in order to get fundamental data, it is necessary that a study of this nature should be repeated and more varieties included before conclusive recommendations are made.

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The Vital Story of VITAMIN C

by Science Writer

What does vitamin C do for human beings?

Medical research shows that it is essential in maintaining healthy bony tissue and for the formation of collagen which is the main supportive protein of skin, tendon, bone, cartilage and connective tissue. It is needed for vascular function and tissue respiration and in promoting the healing of wounds. In lactating women it has great importance in providing the infant with a sufficient amount of ascorbic acid to prevent scurvy, a disease to which very young babies are susceptible.

Much evidence is available in medical reports to show that a lack of this vital nutritive element can result in impaired health. And in those cases of frank scurvy which still occur, ascorbic acid is the specific medication.

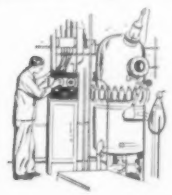
History. The history of vitamin C is fascinating. Scurvy, known for centuries, was once the most prevalent disease in Europe. It afflicted the Crusaders, decimated the crews of voyagers and armies, and plagued the colonists of the New World. In the 18th Century the antiscorbutic value of fresh vegetables and citrus fruits was recognized.

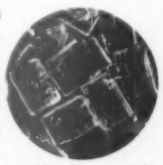
Isolation. It was not until 1918-25 that almost pure ascorbic acid was concentrated from the lemon by Zilva and its important properties and molecular composition established. In 1927 he concluded that this so-called "reducing factor" and the antiscorbutic principle were closely related. In 1928, Szent-Györgyi, who started investigations in 1921, isolated a strong reducing compound from adrenal glands, oranges, and cabbage and termed it "hexuronic acid."

Chemistry. The "reducing factor," "hexuronic acid," and vitamin C were all identified as the same in 1932 by various groups of workers. This was one year after C. G. King, by methods of organic chemistry and experimental physiology, established the chemical identification of vitamin C, thus fulfilling Budd's prediction of 90 years earlier that the antiscorbutic property of certain foods would ultimately be discovered to be a definite substance.

Synthesis. In 1933 Reichstein and his colleagues in Switzerland successfully synthesized ascorbic acid. Almost simultaneously in England Haworth and associates accomplished the same. The Reichstein synthesis formed the basis for large scale commercial production by the world-famous firm of Hoffmann-La Roche.

Production. Following these discoveries came the establishment of manufacturing operations so that today daily production by the tons is the rule. The figures are really staggering. The amount produced weekly in the U. S. A. averages over 15 tons, equivalent to that contained in over 200 million oranges. It is remarkable that ascorbic acid can be produced synthetically and sold for only about $12. per kilogram. One kilo is sufficient to supply 92 people for one year with the minimum daily requirements set by the U. S. Food and Drug Administration.





Vitamin C made by the Roche process is identical chemically and in biological activity with Nature's own product. Because vitamins can be manufactured at a much lower cost than if they were extracted from natural sources they are widely used in dietary supplements and pharmaceuticals. In fact, "New and Non-official Remedies," a publication of the American Medical Association for use by physicians states: "All pure ascorbic acid used in pharmaceutical products is prepared synthetically."

Ascorbic acid is present in many foods. Nature supplies some with lavish amounts and stints on others. In fact, wide variations* have been found in the vitamin C content in varieties of the same fruit.

Deficiencies. Many surveys have shown widespread vitamin C deficiencies in the population. Physicians may call these subclinical, but they are deficiencies nevertheless.

Because of these situations—natural variation and widespread deficiencies—diet experts believe that it is desirable and in the public interest to standardize the vitamin C content of processed fruit and vegetable juices by the addition of enough pure crystalline ascorbic acid to make them consistently dependable sources of this necessary food element. Some of these juices are: tomato, grape, orange, grapefruit, pineapple and apple.

Requirements. The U. S. Food & Drug Administration has set 30 milligrams as the adult minimum daily requirement of ascorbic acid. This daily intake is just about sufficient to prevent recognizable signs of vitamin C deficiencies although a subclinical or an unrecognized deficiency may exist. In view of this, the National Research Council has established 75 milligrams as the recommended daily male adult allowance and 70 mg. daily for female adults, which levels are supported by many controlled nutrition studies. However, the N. R. C. recommends 90 mg. daily for boys between 13 and 15, 100 mg. daily for boys between 16 and 20, and 150 mg. daily for lactating women.

This article is published in the interests of pharmaceutical manufacturers and food processors who make their good products better with essential, health-giving vitamin C. Reprints are freely available. Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

*The table shows minimum and maximum levels of ascorbic acid in commercially canned juices. All figures are in milligrams per 100 grams of juice. Data from U. S. Department of Agriculture.

	Min.	*Max.*
Apple juice	0.2	3.6
Grape juice	0.0	4.7
Grapefruit juice	10.0	49.0
Orange juice	9.7	70.0
Pineapple juice	5.4	18.0
Tomato Juice	2.5	32.0

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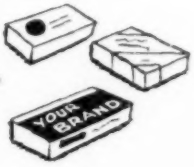

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(Continued from page 32 preceding technical papers)

frozen foods, the effect of constant and variable storage temperatures on texture and structure, improving methods of preparing fruits, meats, and vegetables for freezing, and the development of formulas for precooked foods.

A part of the project on frozen foods has been a study of containers. In this connection existing materials and containers have been evaluated and new ones have been designed and constructed. This research has been conducted in close cooperation with container manufacturers and frozen food distributors. The results are being widely used by housewives, locker plants and commercial packers.

Another phase of the frozen food project is a study of home freezers and their use in the home. The rate of freezing food in different locations of the freezer, as well as the amount of electric current and cost of freezing are among the subjects studied.

Work on concentrating and freezing of fruit and vegetable juices (Figure 3) is still another phase of the program.

Figure 3. High vacuum, low temperature juice concentrating unit at Experiment, used for experimental concentrating and freezing of fruit and vegetable juices.

Curing pork and turkeys. Experiments have been conducted continuously for eight years on improving the quality and increasing the rate of curing, smoking, and aging of country cured pork. This has included hams, bacon, shoulders and sausage, and has recently been expanded to include the curing and smoking of turkeys. The results of these tests have been widely used by farmers, freezer locker plants, and small meat processors. Hams cured country style have a firm texture, very pronounced flavor, deep red color and do not require refrigeration.

Effects of refrigeration. For about ten years this department has been conducting research to determine the advantages of storing processed foods under refrigeration. Facilities are available for holding foods at temperatures ranging from —20° to 100° F., at relative humidities ranging from 35% to 100%. Among the products which have been tested for periods as long as five years are peanuts and peanut products, pecans and pecan products, more than forty items of military rations, canned sweet potatoes, preserves, and pickles of several kinds.

The results from these experiments have been published in numerous technical reports and show remarkable benefits from the use of refrigeration to retard staling and development of rancidity in products containing fats; retarding the browning reaction, preservation of natural aromas, flavors, and colors of vegetables and meat products; and preventing insect activity at temperatures below 40° F.

Improving methods. Special attention is being given to improving methods of processing certain southern grown crops. Among these are okra, southern field peas, muscadine grapes, pimiento peppers, collard greens, canteloupes and watermelon rinds. It was recognized that the advent of freezing opened new methods of preserving these products, many of which could not be satisfactorily preserved by drying, brining, or canning.

Storage of military rations. Of special significance is a project with the Chicago Food and Container Institute on "Long Time Storage of Military Rations." This includes the storage of approximately 45 of the most common items in military rations, packed in tin cans and flexible containers and stored under eleven conditions for periods up to five years. This project is now in its third year.

The teaching program. Food Preservation was taught for some years prior to 1944 by the Horticulture Department. Actually, not until 1947 was the Food Technology Department at Athens expanded sufficiently to offer well-rounded curricula leading to the Bachelor's degree and to the Master's degree. Since 1948, 68 majors in Food Technology have graduated with the Bachelor's degree, and, since 1949, 19 Master's degrees have been awarded. At present the Department has 30 undergraduate majors and five graduate students. During the past few years several special foreign students have spent from one quarter to a year studying food technology at the University of Georgia.

The general philosophy as far as the curriculum is concerned is to give students as broad and as basic a background as possible, taking into account the fact that graduates terminating their formal education at the Bachelor's level must have sufficient practical work to be of immediate value to an employer when they enter industry. For a few years the Department had to contain its ideas as to a proper curriculum within the frame-

(Continued opnage 40)

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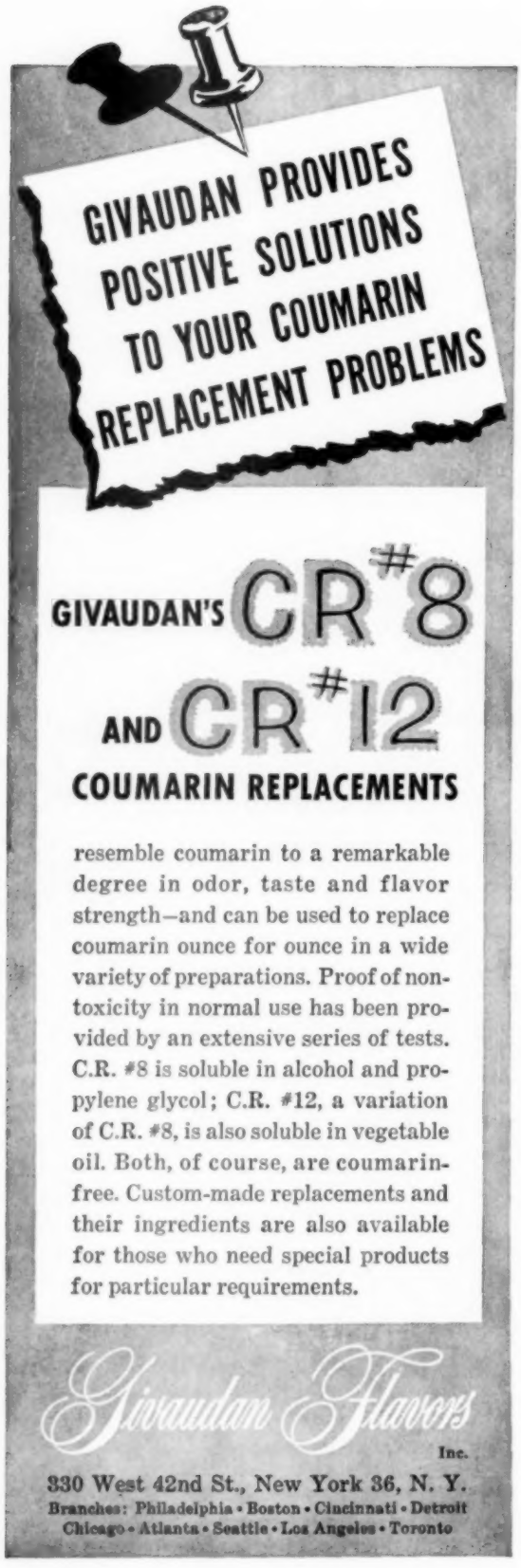
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(Continued from page 38)

work of the general agricultural curriculum, but two years ago, the College of Agriculture authorized a special curriculum for majors in food technology to permit the substitution of additional chemistry, mathematics, and engineering in place of some of the agricultural subjects required of other majors. At present the curriculum is as follows:

Freshman and Sophomore Years

Course	Quarter hours	Course	Quarter hours
Economics	3	Heat engineering	3
Engineering drawing or engineering shop	3	Refrigeration engineering	3
Botany	10	Soils	5
Zoology	5	Qualitative Chemistry	5
Inorganic Chemistry	10	Speech	5
English	10	Political Science	5
Algebra	5	Physics	5
Horticulture	3	Electives (selected from accounting, any field of agriculture, foreign language, nutrition, philosophy, psychology, a second course in public speaking)	10
Trigonometry	5		
Organic Chemistry	5		
Military or Air Science	10		

Junior and Senior Years

Course	Quarter hours	Course	Quarter hours
Introductory Food Technology	5	Quantitative Chemistry	5
Industrial Practices	10	Mycology	5
Chemistry and Microscopic food analyses	5	Bacteriology	5
Food Packaging	5	Science elective (selected from analytical geometry, calculus, statistics, plant physiology, animal physiology, genetics, entomology, physiological chemistry)	10
First minor[1] (in any department of the University)	10		
Second minor[2] (in any department in the College of Agriculture)	10	Electives[3]	25

[1] The first minor is generally in chemistry, bacteriology, mathematics, or some phase of business administration.

[2] The second minor is usually in dairy, horticulture, poultry, agricultural economics, entomology, or botany, the latter two departments being joint-staffed with College of Agriculture.

[3] Electives during the senior year permit Food Technology students to select one or two more food technology courses to meet their particular needs as well as courses in any field they wish. Food Technology courses available in addition to those listed above include: Microbial food analysis, Instrumental methods of food analysis, Meat slaughtering and curing; Poultry processing (taught jointly by Poultry and Food Technology Departments); Advanced technology of meat, fish, and poultry processing; Technology of frozen and refrigerated foods; Handling and packaging of fresh fruits and vegetables (taught by Horticulture Department).

The purpose of the Food Technology curriculum is to have all students acquire a sound, fundamental background in the principles and practices involved in the production of foods and their analysis; beyond that point, students may specialize in production phases or analysis, depending upon their particular interests and abilities. Students who contemplate graduate work are steered into additional chemistry, physics, mathematics, bacteriology, and foreign language courses as undergraduates, leaving a greater proportion of their food technology courses to be taken as graduate students.

In addition to the major course work, members of the Department of Food Technology at Athens teach the food bacteriology courses in the Department of Bacteriology. The Food Technology Department offers a general food preservation course which all majors in

(Continued on page 42)

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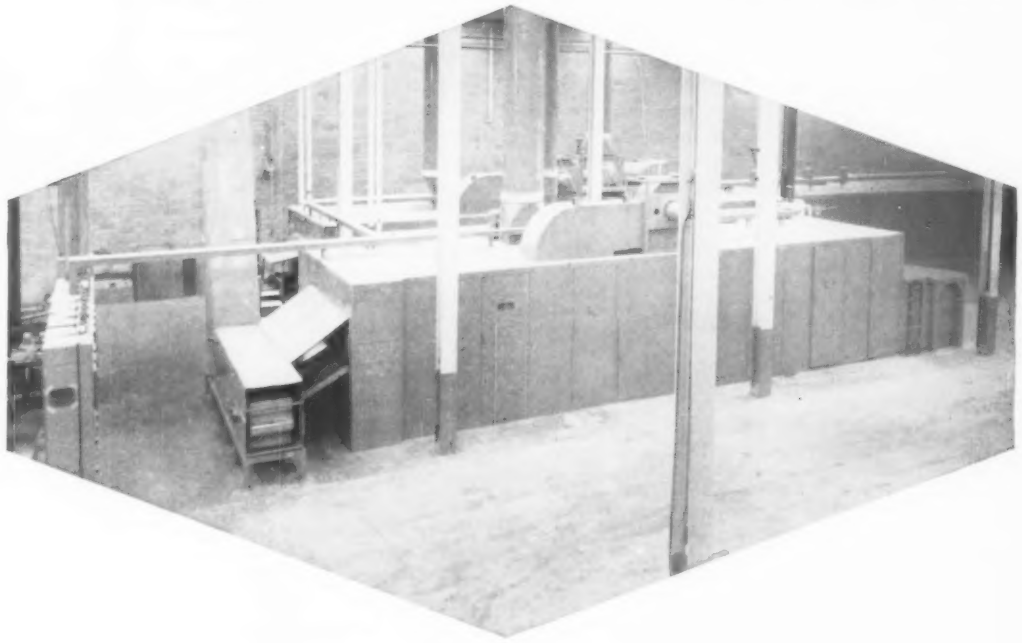

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(Continued from page 40)

Vocational Agrciulture must take—and which is often elected by home economics, poultry, dairy and agricultural economics majors. The course in meat slaughtering and cutting must be taken by all Animal Husbandry majors.

Research conducted as part of the thesis research programs of the graduate students and College Experiment Station research are closely integrated. At Athens the research projects have dealt mainly with pimiento processing, field pea canning, thermal processing or food spoilage problems, fermentation of pickles, meat curing, and poultry processing.

The extension program. The food preservation program of Extension Service is carried out through Home Economics agents in cooperation with engineers, horticulturists, and others. The extension program covers a wide range of subjects and products including frozen foods, home freezers, corn meal improvement, curing pork country style, as well as home canning, preserving, pickling, and other methods of food preservation. Improving the nutritional level of farm people is one of the major objectives.

SUMMARY

Work in food processing in the College of Agriculture of the University of Georgia includes research, teaching and extension, and includes fourteen full-time staff members. Teaching is centered in Athens, where research work is also done; but the bulk of the research work is located at Experiment; and the extension work covers the state. These activities are coordinated under the Division Chairman.

A charter for a chapter of the Phi Tau Sigma Honorary Society was presented to the Food Processing Department of the University of Georgia in June 1956.

BOOKS . . .

FOOD POISONING. G. M. Dack. The University of Chicago Press, Chicago, 1956.

This comparatively small, factual volume (234 pages of text and references, exclusive of index) is notable for its concise, succinctly written information. First of all, the cautious, critical approach is used to discuss the different biological and chemical kinds of food poisoning. This approach is very important if the uninformed reader is to gain an unbiased understanding of the general subject. Secondly, the text is tempered by ample critical analyses of the literature on food poisoning. Finally, the "pros" and "cons" of the controversial subjects are treated in an unbiased manner. Every effort is made to point out the discrepancies in the literature and, within limits, these discrepancies are further documented by the author's own experiences as a nameless volunteer (See Food Technol., *10*, (4), 28, 1956).

The author has made a definite contribution to the "stream of knowledge" by considering the newest aspects of the subject and has successfully covered the literature into 1955. That the author is aware of the current advances is indicated by the opening remarks in the preface to the Third Edition of *Food Poisoning*—"Since the publication of the last edition of *Food Poisoning*, progress involving all classes of causative agents has been made in the entire field of food poisoning. The problem of chemical additives to foods has received increased emphasis in our law-enforcement agencies. New material has been added in this book on plant and animal poisons in foods. The portion dealing with bacterial food poisoning has been increased and extensively revised."

This volume is unqualifiedly recommended to all those food technologists interested in the various phases of biological and chemical food poisoning. However, the reader should remember that the complete spectrum of food poisoning is not treated in this volume, or for that matter, in any similar book the reviewer has studied.

REESE VAUGHN
Davis, California

CONGRESS REPORT, 3rd International Bread Congress, Hamburg 1955, Granum-Verlag, Detmold (310 pp.).

The 3rd International Bread Congress was held from May 31 to June 3, 1955, in Hamburg, under the patronage of the German Minister for Food and Agriculture. Scientific workers and technicians in the cereal field from 34 countries participated.

The congress report has been published, and it includes all 83 papers read at the convention, complete with illustrations and tables. The publication is arranged in six sections: Nutrition physiology and feeding stuffs; grain breeding and standardization; research methods; grain storage and milling technology; hard wheat milling and hulling industry; and baking technology.

It also includes valuable information about the formation of the International Standardization Committee, the principal purpose of which is the establishment of standard methods for the evaluation of food grains.

Contributed by DR. MENGER

In Memoriam

News of the death of Harry J. Deuel, Graduate Dean, University of Southern California, on April 17, 1956, was received with deep sorrow by his host of friends and associates in the scientific world. Dr. Deuel's research on the metabolism of fat, on carotene and vitamin A and numerous other major projects brought him to leadership in his field many years ago. He found time in addition to his research pursuits to take an active part in the activities of professional groups—the American Chemical Society, the Institute of Food Technologists, and many others. His publications are to be found in the leading scientific journals, and his two-volume work, THE LIPIDS, is standard for the field. In the hearings to establish the permissibility of coloring margarine, Dr. Deuel was heavily called upon. During his lifetime he received many awards—the Monsanto Award for the outstanding IFT annual meeting paper (1953), the Borden Award (1949), and most recently a Fulbright Fellowship to England.

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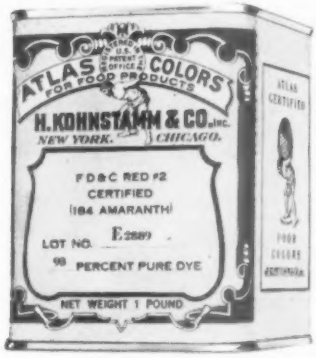

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AN OUTSTANDING GROUP . . .

Winners of the 1956 scholarship awards represent a variety of technical interests as well as geographical regions. As the following brief accounts will reveal, the successful candidates are at work on difficult, challenging problems in science or engineering as they relate to food. It is obvious that good scholarship, like gold, is where you find it. Canada, Oregon, California, Massachusetts and Wisconsin are the home regions of this year's awardees.

The Gerber Baby Foods Post-Doctorate Fellowship Award

Dr. J. C. MacDonald was selected for the Gerber Fellowship, which is given to promote research in some newer phase of food science and carries with it a stipend of $6000 per annum.

J. C. MacDonald was born in Medicine Hat, Alberta, Canada, on November 3, 1926, and received his elementary education in this city. He attended the University of Alberta from 1945-49, obtaining the degree of Bachelor of Science with first class honors in chemistry. Post-graduate studies were carried out in the Department of Physiological Chemistry, University of Wisconsin, where he obtained the M.S. degree (Physiological Chemistry) in 1951 and Ph.D. degree (Physiological Chemistry) in 1953. His post-graduate research for these degrees was done in the McArdle Memorial Institute for Cancer Research, in association with Dr. J. A. Miller and Dr. E. C. Miller. This research was concerned with the carcinogenic and nutritional effects of certain azo dyes, and also with their metabolism. From 1953-55 he did post-doctoral research in England on a fellowship donated by the Anna Fuller Fund. In this research Dr. MacDonald was associated with the Medical Research Council, Unit for Research in Cell Metabolism, directed by Professor H. A. Krebs. This post-doctoral research, done with Dr. D. E. Hughes, was concerned with the metabolism of one of the B-complex of vitamins, biotin. He is carrying on investigations on this subject at McMaster University on a post-doctoral fellowship from the National Research Council of Canada, and intends to continue these investigations with the help of the Gerber Fellowship.

Dr. J. C. MacDonald, Gerber Post-Doctorate Fellow, will further explore the metabolism of one of the B-complex of vitamins

General Foods Fellowship Awards

Three recipients were named for this honor in 1956—Edmund Lusas, Wisconsin; John A. Schnautz, Oregon; and Vincent P. Maier.

Edmund Lusas was born and raised on a dairy farm in Woodbury, Connecticut. Following a year of dairy farming after his education, he entered the University of Connecticut, graduating there with a major in Dairy Manufacturing in 1954. He was a member of the University of Connecticut Dairy Products Judging Team which placed second in the 1953 National Collegiate Dairy Products Judging Contest. He received the M.S. degree in Food Technology at Iowa State College in 1955. His studies there included research on the effects of white metal corrosion in stainless steel-white metal dairy plant systems upon oxidized flavor development in dairy products.

Mr. Edmund Lusas, General Foods Fellow, is concerned with anthocyanin—specifically the anthocyanin pigments in beets.

Mr. Lusas is currently a graduate student working toward the Doctorate degree in Food Technology at the University of Wisconsin. His research work is centered on a study of factors affecting the stability of the anthocyanin pigments in beets. He is a member of Alpha Zeta, Phi Kappa Phi, and Gamma Chi Epsilon honor societies, The Institute of Food Technologists, American Chemical Society, American Dairy Science Association, and The International Association of Milk and Food Sanitarians.

John A. Schnautz, graduate student in Chemical Engineering at Oregon State College, Corvallis, Oregon, is also a recipient of a General Foods Fund Fellowship for the school year 1956-57. He is now working on the mass transfer processes between granular solids and fluid streams. The study is being guided by Dr. C. E. Wicks, Assistant Professor of Chemical Engineering.

Mr. Schnautz received his B.S. Degree from Iowa State College in 1951, majoring in Food Technology. He then served in the U. S. Army Veterinary Corps attached to the 6th Army Area Medical Laboratory,

(Continued on page 46)

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(Continued from page 44)

handling special assignments for the Veterinary Corps and for the Quartermaster Corps relating to quality testing and procurement of foods of both animal and non-animal origins. Upon completion of military service, he transferred for graduate study to Oregon State College, and received his M.S. Degree in Food Technology in 1956 at that institution.

Mr. John A. Schnautz, General Foods Fellow, will seek a better understanding of mass transfer processes between granular solids and fluid streams.

He is a member of Phi Sigma, Sigma Xi, Sigma Tau, Phi Mu Epsilon, IFT, A.C.S., and A.I.Ch.E.

Mr. Vincent P. Maier has attended Santa Ana College, the University of California at Los Angeles and, currently, the University of California at Davis. He holds his Bachelor of Science degree from U. C. L. A. (1952) where he specialized in subtropical horticulture.

In 1954 he obtained his Master's degree from the University of California at Davis, working on the interesting problem of enzyme kinetics at low temperature.

Mr. Vincent P. Maier, General Foods Fellow, is interested in hematin compounds catalyzed by fat oxidation.

As a General Foods Fellow, he will continue work for his doctorate in the field of hematin compounds catalyzed by fat oxidation. After graduation, Mr. Maier expects to do both applied and basic research on chemical and biochemical problems in the food industry. He is not unfamiliar with industrial procedures, having worked as a quality control laboratory technician in the citrus concentrate branch of the industry, as a foreman, and as a research laboratory technician in the same field of food manufacture during several summer vacations.

THE FLORASYNTH AWARD

The award of the Florasynth Laboratories, Inc. was won by Thomas L. Fazzina of the Department of Food Technology, Massachusetts Institute of Technology, Cambridge. The award is for the academic year 1956-1957.

Thomas L. Fazzina, born in 1928 in New Britain, Connecticut, received his secondary school education there, and in 1946, entered Georgetown University, graduating in 1949 with a B.S. in biology and philosophy.

For several years, as a student in the Biochemistry Department at Boston University Medical School, Mr. Fazzina engaged in varied activities dealing with medical science and clinical medicine. These include: a study of the effects of irradiation on nucleic acids; night supervisor of the Boston City Hospital Blood Bank; lecturer in medical science at various nurses' schools; consultant to the Gastric Laboratory of the Massachusetts Memorial Hospitals; and advisor to several medical clinics. He was granted his Master's degree in biochemistry in 1954.

Thomas L. Fazzina . . . Florasynth Award recipient to continue study at M. I. T.

Mr. Fazzina entered the Department of Food Technology, Massachusetts Institute of Technology, in the fall of 1954. As a Ph.D. candidate, he has spent the past two years preparing himself for the doctorate qualifying examination. During this period he has been at work on a series of promising tests for fish quality evaluation and information cataloging systems.

Consistently an M.I.T. scholarship winner, he has found time for graduate school activities. He is Associate Editor of the *Graduate Student News* at M.I.T. and a member of the Graduate Student Council.

Mr. Fazzina has found time also for activities in the business world. Working in the wholesale meat and restaurant areas, he has been responsible for the development of product ideas and production methods for several well-known specialty products.

Well liked by his associates, Tom Fazzina has given strong indication of the heights he can be expected to attain as a professional food technologist.

FOOD INDUSTRY TOPICS...

. . . by Norb Leinen

. . . in the public interest

A revolutionary new plan to master the nation's number one domestic problem, the farm surplus, was described recently by Mr. John S. Williams, senior vice president and director of Cunningham & Walsh, New York advertising agency. Essence of the plan is to sell this surplus both here and abroad by a large-scale use of the modern advertising and marketing techniques that have made the U. S. the world's greatest merchandiser. Pointing out that farm surplus had cost taxpayers over $22 billion in 3 years, and that storage costs alone were more than $1 million a day, Mr. Williams stated that the problem of selling farm commodities held by the government is essentially the same as selling an inventory excess for a business organization—the only difference being one of degree. He proposed that the government establish a Farm Surplus Marketing Commission, set up on a non-political basis similar to the Atomic Energy Commission. This Commission would select advertising agencies on a competitive basis, and each agency thus selected would be given an advertising appropriation for a specific surplus commodity, such as butter, wheat, corn, or cotton. The agency then would study both domestic and foreign markets, develop new outlets, create new uses for the commodity, and then promote and advertise it. The agency executive said there was no danger that his plan would create an unfair competitive advantage for government-held commodities over privately marketed ones. He pointed out that although nominal competition would exist, experience shows that such competition normally extends commodity markets rather than restricting them.

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Modern science can help raise living standards throughout the world despite growing population pressures, members of the Brooklyn Rotary Club were told recently by Mr. John E. McKeen, president of Chas. Pfizer & Co., Inc. Pointing out that although "mass disease is still a birth-to-death burden" for more than half the world's people, he declared that "modern science has begun to cut down this terrifying toll of human waste." He cited malaria control programs in India, Greece, and other countries which have increased the area of land under cultivation, and antibiotic programs for treating tropical yaws which have "raised hope of eliminating this age-old scourge forever." Mr. McKeen referred to estimates that world population will increase more than 500 million by 1975, and noted that advances in agriculture can help meet global needs for more food. "American farmers have shown that scientific agriculture and farm mechanization can wring more abundance from the soil with less manpower," he said. In a similar way, he added, plastics, synthetics, and man-made fibers will help offset dwindling natural resources as population grows.

New design Refrigerant Condenser

...gives far more efficiency and better, trouble-free service

With this new, sectional design Niagara condenser you avoid the many troubles due to faulty condensing and get at all times the full capacity your refrigerating plant should afford.

You benefit from extra saving in upkeep labor and expense. The casing of this new condenser is made of sections each separately removable, giving you access to all parts for easy inspection to head off dirt and corrosion, to clean the coils easily from either side.

You benefit from greater efficiency in condensing. A simpler method of using evaporative cooling improves heat transfer. You benefit from Niagara features that remove super-heat before condensing and keep the system purged of oil. You save 95% of the cooling water cost.

You benefit from a low first cost, lower freight cost and less expense in erection.

Capacity range is from 90 to 240 tons. Write for Niagara Bulletin 131. Find out how your plant can save expense this season.

NIAGARA BLOWER COMPANY

Dept. F. T., 405 Lexington Avenue
NEW YORK 17, N. Y.

District Engineers in Principal Cities

NIAGARA — *Over 40 Years' Service in Industrial Air Engineering*

The Glycerine Producers Association, 295 Madison Ave., New York 17, N. Y., announces opening of the fifth annual Glycerine Research Awards. First award is $1000 and an honor plaque, second award $300, and third award $200. These awards are granted for independent research leading to new and improved applications of glycerine or glycerine derivatives to products or processes. Copies of the bulletin giving complete details on the awards may be obtained from the Association.

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The rules for the 1956 competition for the D&O Achievement Award have been amended. Nominations now are open for any contribution to the growth and general welfare of the Meat Packing Industry that is of recent origin, but in use long enough to have proven its advantageous qualities in some phase of the industry. It is no longer limited to achievements made public during the award year. The award, consisting of $1000 and a gold medallion, may be won by any individual or corporate member of the industry in all areas of research, operating, and engineering, and there are no restrictions as to age, sex, or nationality. For complete information and entry blank, write Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. Nominations close August 1.

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Opening of Podbielniak Institute as a self-sustaining but essentially non-profit institution to make available to the industries special instruction and training courses in analysis of gases and vaporizable liquids is announced by Podbielniak Institute, 341 E. Ohio St., Chicago 11, Ill. The first 5 two-week sessions will begin on the following dates: September 24, 1956; November 5, 1956; December 3, 1956; January 21, 1957; and February 25, 1957. Attendance is required from 8:30 a.m. to 5:30 p.m., Monday through Friday, for the duration of the course, for lectures and demonstrations. Tuition for each two-week course is $500. For further information and applications, write Mrs. Helen Kastruba, registrar, at the above address.

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A novel method some dairies are using to dispose of their waste material is about to be studied by the University of Wisconsin for the USDA's Agricultural Research Service, according to terms of a contract announced recently. The method, also applicable to cannery and other food processing wastes, is called spray irrigation. It consists of irrigating an open field with liquid wastes pumped from the processing plant. "The Department of Agriculture has long been interested in the dairy waste disposal problem," says Dr. P. A. Wells, chief of the Department's Eastern Utilization Research Branch, which is supervising the contract. "It is one that threatens the very survival of many small dairies that are no longer permitted to dispose of their wastes in rivers and streams because of pollution control legislation." Study of the spray irrigation method is expected to get under way this summer under direction of Profs. Gerald A. Rohlich and L. E. Englebert, of the University of Wisconsin.

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National Starch Products Inc.'s continuation on a broader basis of its scholarship program in chemistry and chemical engineering was announced by Mr. Frank Greenwall, president. The schools involved are Columbia University, Case Institute of Technology, University of Nebraska, North Carolina State College, Syracuse University (N. Y. State School of Forestry), and Rutgers University. The program was initiated to help alleviate the serious shortage of technical graduates who are so necessary for the maintenance of our country's technical supremacy. In addition to studying in the general fields of chemistry and chemical engineering, applicants also must need financial assistance and be of outstanding scholastic ability and high character. Recipients of the scholarships are under no obligation as to future employment with National Starch.

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On April 27, the United States Brewer's Academy, Mount Vernon, N. Y., held ceremonies for the 72nd class to be graduated since the school's founding by Anton Schwarz in 1882. Its students, who come from all over the world, will go to executive and technical positions within the brewing industry. The USBA is the primary source of training personnel for the brewing industry. No U. S. college or trade school offers a curriculum in brewing chemistry, and the European schools teach European methods. Ten instructors teach an average class of 20 hand-picked students, all of whom must have had 2 years' experience in the industry and a high-school diploma. The majority are college graduates. The students are trained for seven-and-one-half months in every phase

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

July 10-12	Western Pack and Materials Handling Exposition, Los Angeles, California
August 6-10	Gordon Research Conferences, AAAS Conference on Food and Nutrition, Colby Junior College, New London, New Hampshire
August 13-15	International Apple Association, Atlanta, Georgia
August 17-25	Tenth International Congress of Entomology, McGill University and the University of Montreal, Montreal, Canada
September 5-7	International Ass'n of Milk and Food Sanitarians, Olympia Hotel, Seattle
September 10-17	The Perkin Centennial, Sponsored by the American Assoc. of Textile Chemists and Colorists, Commemorating the Discovery of Aniline Dyes, Waldorf-Astoria, New York
September 16-21	One hundred and thirtieth National Meeting of the American Chemical Society, Atlantic City, New Jersey
October 9-12	American Dietetic Association, Milwaukee
October 17-19	Nat'l Pickle Packers Association, Edgewater Beach Hotel, Chicago
November 12-15	American Bottlers of Carbonated Beverages, Public Auditorium, Cleveland
November 27-30	National Chemical Exposition, Public Auditorium, Cleveland

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

of brewery operation and in the fundamental principles of the brewing process. The laboratory itself is frequently the source of new progress. For example, it was the first to discover that beer is comparatively rich in the B complex vitamins, thus greatly enhancing its value as a nutrient. It developed an air and CO_2 tester which now is a conventional quality control instrument. The laboratory also discovered that a major source of taste trouble lay in volatile sulfur compounds, and developed a method for detecting the presence of these compounds.

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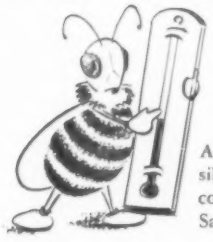
An investigation of the feasibility of tenderizing beef through a combination of processes of freeze-dehydration and enzyme application during rehydration prior to cooking has been undertaken by the American Meat Institute Foundation, 939 E. 57th St., Chicago 37, Ill., pursuant to a research contract with the Quartermaster Food and Container Institute for the Armed Forces, Chicago. The specific research objective is to determine whether frozen-dried beefsteaks can be brought to a high tenderness rating through application of an appropriate combination of proteolytic enzymes. Collaborating in the project will be the Foundation's Division of Histology under the direction of Dr. Hsi Wang, and the Division of Home Economics under the leadership of Dr. C. Edith Weir. Drs. Wang and Weir and their associates will utilize only the less tender types of beef in the new program. Freeze-dehydrated steaks will be provided through commercial pilot production sources, and these steaks will be rehydrated by soaking in water to which one or more of the proteolytic enzyme preparations has been added. Following treatment, the steaks will be subjected to histological and taste panel evaluation in order to procure a correlated picture of the relationship between the altered structural composition of the meat and any improvements in tenderness. Such a correlation, if established, will materially expand the currently very limited knowledge of the fundamental nature of tenderness, and may provide the basis for the development of commercially practical processes for tenderization of frozen-dried beef.

. . . *things new under the sun*

A new liquid mold and rope inhibitor made of metabolizable food products has been introduced by Mallet & Co., Inc., 601 E. General Robinson St., Pittsburgh 12, Pa. Called "Myxnix," the product is odorless, tasteless, and reportedly will provide 3 to 4 times the effectiveness of conventional mold inhibitors. It was developed especially to combat spoilage in cream and custard pie fillings, fruit toppings, cookie fillings, cheese cakes, pie crusts, icings, bread, and all other yeast raised baked goods. Easily incorporated into batters and fillings, it will not adversely affect color, taste, or texture of end item when used properly. "Myxnix" is a selective mold inhibitor. When used as prescribed, only the growth of harmful molds and bacteria is suspended, while the free, fermentative

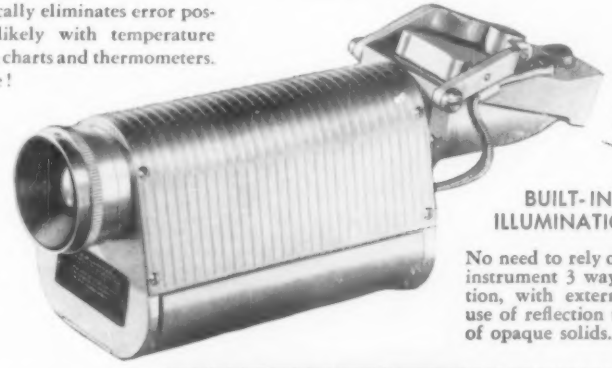
HOW NEW AO HAND REFRACTOMETER CUTS COSTS

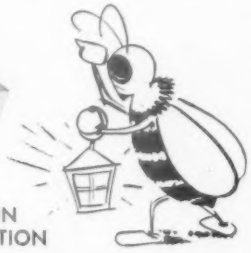


BUILT-IN TEMPERATURE COMPENSATION

Automatically eliminates error possibilities likely with temperature correction charts and thermometers. Saves time!

Refractometric determinations are important in your pick or pack problems. The new AO Hand Refractometer will save you time, effort and money . . . here's how.





EASY-TO-READ SCALE

Unusually clear eyepiece image assures reading accuracy to 1/10 of one percent. Dividing line appears in sharp contrast even with dark colored liquids. Scale graduated in increments of 2/10 of one percent, has range of 0-30% sucrose (or degrees Brix).

BUILT-IN ILLUMINATION

No need to rely only on external light. Use instrument 3 ways; with built-in illumination, with external light source, and by use of reflection technique for analyzation of opaque solids.

ANYONE CAN USE IT

New AO Hand Refractometer is fast . . . low cost . . . requires no special training, no computations . . . direct reading scale gives immediate, accurate, on-the-spot determinations.

American Optical

Instrument Division
Buffalo 15, N.Y.

Dept. G190

Please send full information on the new AO HAND REFRACTOMETER.

Name .....

Address .....

City ..... Zone ..... State .....

action of useful yeasts is permitted. Available in gallon jugs—4 to a carton—and 30- and 55-gallon steel drums.

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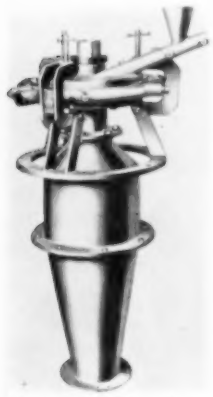
An improved series of fluid jet grinding machines, designed to reduce solids to particles in the micron range at a solid feed rate of up to one-and-one-half tons an hour, has been introduced by the Sturtevant Mill Co., Boston, Mass. The Micronizer has no moving parts but operates on the principle of high speed rotation of particles caused by jets of compressed air or steam at angles to the periphery of the shallow grinding chamber. The particles, through violent impact, tend to pulverize each other. No problems of attritional heat are encountered. Sturtevant offers 7 sizes of the unit, ranging from a laboratory model with a 2″ grinding chamber and a half-pound-per-hour capacity, to the largest 30″ model with a capacity of 3000 pounds per hour. Material used in fabrication of the Micronizer is usually dictated by the characteristics of the substance to be ground. One popular material of construction is stainless steel. Major use to date has been the simultaneous dry grinding and classification of solids. For details, write the firm c/o F. P. Walther Jr. and Associates, Inc., 172 Newbury St., Boston 16, Mass.



Large model Micronizer

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Availability of cementable Teflon tape in thicknesses as low as .005″ is announced by Garlock Packing Co., Palmyra, N. Y. The thinner tape, lower in cost, will expand use of Teflon as linings for conveyor guide rails, hoppers, baking pans, cookie flats, and other work surfaces handling foodstuffs, corrosive materials, etc. Non-toxic, non-contaminating, chemically impervious Teflon tape is furnished with a slippery surface on one side and a specially prepared surface on the other that can be bonded with commercial adhesives to wood, glass, metal, and other surfaces. In addition to its anti-sticking surface characteristics, Teflon possesses excellent dielectric properties and a broad service temperature range (—110° to 500° F.). The new cementable Teflon tape is available in continuous rolls in thicknesses from .005″ to .060″—in widths from ½″ to 12″. Write for catalog AD 158.

◆ ◆ ◆

A foolproof water mixer that shuts itself off in case of thermostatic motor failure is offered by Powers Regulator Co., 3434 Oakton St., Skokie, Ill. The Type N Hydroguard will also shut off the required port in the event of hot or cold water supply failure. Unique features include rotating inlets and outlet, which turn in 90-degree steps so that the mixer can be installed in any position. Temperature settings in the 65-115° or 85-160° F. ranges are controlled by a concealed adjustment which can be locked to prevent tampering. Available in 45 (N-45) and 125 (N-125) gallons-per-minute capacities. Sold by plumbing wholesalers and jobbers, prices are $150 for the N-45 in rough bronze, and $210 in chrome plate. The N-125 is $225 in rough bronze and $300 in chrome plate. Shipping weights are 18 pounds for the N-45 and 30 pounds for the N-125. Write for Bulletin 362.

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Film thicknesses of 50 to 60 mils per spray coat, triple the thickness previously possible, can be obtained with a **newly formulated sprayable plastisol** produced by Electroplating and Coatings Division, Metal & Thermit Corp., 100 Park Ave., New York 17, N. Y. Known as "Unichrome Super 5300," the coating makes possible gun application of the full solids content of vinyl plastisol without a diluent, the firm reports. As a result, a pore-free 50 to 60 mil coat can be applied successfully in one layer, which gives "sheet" protection to tanks, ducts, and other large equipment. A compound based on vinyl resins, Unichrome Super 5300, is resistant to the corrosive action of strong acids, concentrated caustic, and salt solutions and other corrosive materials. Satiny-smooth in appearance, the material forms a tough, flexible film which absorbs impact without chipping, withstands abrasion, and has desirable acoustical and electrical insulating properties. Field evaluation reports indicate that the new plastisol coating permits the substitution of ordinary metals for costly alloys.

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Continental Can Co., 100 E. 42nd St., New York 17, N. Y., first to develop the frozen juice concentrate can with cemented side seam, announces availability of this container in 6-, 12-, and 32-ounce sizes. This full family of sizes fulfills container requirements of the citrus industry, and offers packers the advantage of wrap-around body lithography. Each of the sizes may be used to hold the following frozen juice products: apple, cherry, pineapple, tangerine, lemon, orange, grape, and grapefruit juice concentrates; grapefruit-orange and other citrus concentrate blends; lemon juice, single strength; lemonade base concentrate; lime ade; lime juice; and orange juice single strength. The solderless containers may be used with all types of canner freezing equipment and can handling systems, and will perform equally as well as soldered side seam cans. Prices are the same as on the latter type of cans.

Continental also announces availability of Eas-E-Namel release agents for quicker, easier removal of the contents of pet food and luncheon meat cans. Cans for other food products, such as canned hams and canned bakery items, shortly will be available with this new development.

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A roller chain which is non-corrosive and costs 40% less than stainless steel chain, has a tensile strength equal to alloy chain, and minimizes friction drag due to electrolyzed parts has been introduced by

(Continued on page 52)

CONTINENTAL *Landmarks*

Periodic progress reports of interest and value to the food processing field

Significant Development in Beaded Cans

New cluster-beaded cans offer greater paneling resistance—increased axial strength

A new kind of beaded can, made with two clusters of narrow beads packed equidistant from the ends of the container, now offers packers substantial advantages over the conventional wide-beaded can.

In addition to improved axial strength and paneling resistance, Continental's three sizes of cluster-beaded cans provide the following extra benefits:

1. **Less metal exposure in enameled cans.** Absence of inside tabs eliminates possibility of enamel damage at side-seam, thus reducing metal exposure.

2. **Cleaner inside surface.** Cluster-beaded cans have no inside tabs—hence no uneven soldering.

3. **Better labeling surface.** The new cluster-beaded can offers much more flat surface to assure positive adhesion of labels and reduce the chance of tearing or breaking.

Continental's cluster-beaded cans were introduced to the food packing industry less than a year ago, and are now in extensive commercial use. This is typical of the many new packaging ideas now coming from our Metal Division research and development center in Chicago—as well as Continental laboratories coast to coast.

CONTINENTAL CAN COMPANY

EASTERN DIVISION: 100 E. 42nd St., New York 17
CENTRAL DIVISION: 135 So. La Salle St., Chicago 3
PACIFIC DIVISION: Russ Building, San Francisco 4

TAILOR-MADE PACKAGE SERVICE

(Continued from page 50)

Atlas Chain and Mfg. Co., West Pittston, Pa. Called Atlas Electrolized Roller Chain, it reportedly meets the most exacting requirements of the chemical, food, confectionery, beverage, brewing, bottling, packaging, dairy products, pharmaceutical, and other industries where corrosion resistance is an important factor. It has successfully resisted the corrosive action of acetic, citric, nitric, and sulphuric acids, beer, bleaching powder, blood, buttermilk, cola syrup, hydrogen peroxide, salt and salt spray, and sugar cane juice, among others. The chain is made in all Standard American Roller Chain sizes, and meets and beats all accepted roller chain specification standards.

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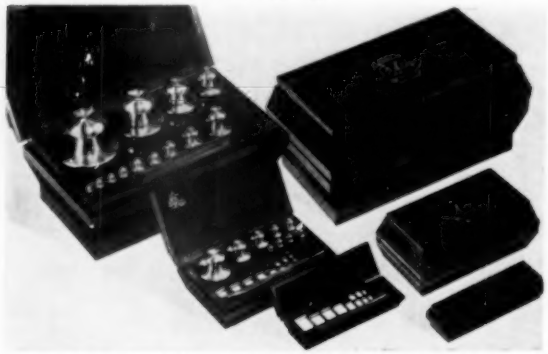

A new line of weights contained in hinged Sto-A-Weigh boxes is announced by Ohaus Scale Corp., 1050 Commerce Ave., Union, N. J. The weights are designed to comply with new Bureau of Standards specifications for classes Q and P, and the conventional class C. Sets are available in 5 different sizes and cover the most popular ranges. Each set is equipped with a pair of stainless steel forceps.

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The new Minox Electronic Flash, weighing a mere 24 ounces, has been introduced by Kling Photo Corp. (sole U. S. Minox distributors), 257 Fourth Ave., New York, N. Y. Designed as a companion to the ultra-miniature 2½-ounce Minox Camera, it incorporates all the latest electronic engineering developments. Unexcelled for candid photography, the compact Minox Electronic Flash can be carried over the shoulder as easily as a pair of binoculars. Because it is designed without bulky flash-heads and dangling wires, it also can be carried conveniently in a man's pocket or in a lady's purse. Priced at $82.50, complete with genuine top-grain leather case, tiny flash-head, and folding fan reflector, the ultra-miniature Minox Electronic Flash is available through all authorized Minox dealers.

◆ ◆ ◆

A new mounting for submersible pump operation has been developed by ECO Engineering Co., 12 New York Ave., Newark 1, N. J., for their standard line of Type 20 alloy centrifugal pumps. Featured in the design is an all-Teflon adjustable thrust and guide bearing which eliminates need for external lubrication. The fluid pumped acts as the lubricant since the Teflon bearing is in rotational contact with a Teflon sleeve on the pump shaft. Thus, the user is not confronted with the possibility of lubricant contamination or bearing failure due to improper lubrication or lack of lubrication. Weighing less than 100 pounds, the entire unit is portable. One pump can handle dissimilar chemicals since it is not limited by choice of bearing materials or lubricants. The combination of Type 20 stainless steel construction with the chemically inert Teflon bearing permits usage in severe corrosive service. Furnished in heights to 60″ from the base, pumps are provided with statically and dynamically balanced, closed or semi-open impellers. Maximum particle size when handling suspensoids or slurries is 1/16″. Capacities to 45 g.p.m. and heads to 50′.

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New printable tapes made with Du Pont's Mylar polyester film that will enable a manufacturer to advertise his product while sealing or packaging are offered by Permacel Tape Corp., New Brunswick, N. J. Known as Permacel 95 and 951, the pressure-sensitive tapes are especially suitable for labeling and sealing containers of the many common oils and solvents to which they are resistant. Because of their extreme thinness they are not likely to be picked or rubbed off. P95 is a transparent tape; P951 is available in red, black, white, and chrome, a metalized finish. Both are available in sizes from ¼″ to 23″.

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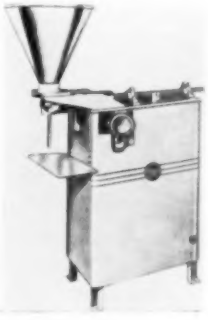

Hope Machine Co., 9400 State Rd., Philadelphia 14, Pa., has introduced a small (45″ long x 29″ wide x 63″ high—400 pounds) Filling Machine for food products, adhesives, oils, greases, and any other liquid, viscous, or semi-solid products. The unit is intended especially for small operations, pilot runs, laboratory testing, small batch runs, and short production runs of certain colors of products. Specifications include a capacity of up to one quart per stroke, speeds ranging from 12 to 25 strokes per minute, and a hopper capacity of 40 quarts. The machine fills containers ranging from ¾-ounce to 32-ounce size.

◆ ◆ ◆

A new combination package is offered in a rigid aluminum foil container produced by Ekco-Alcoa Containers Inc., and a transparent polystyrene cover produced by the Arvey Corp. The cover material used is Polyflex, manufactured by the Plax Corp. The container features a vertical flange rim for easy and automatic closure, simplifying production and lowering packaging costs. The Polyflex cover provides complete flexibility of cover design, allowing all or any part of the product to be visible in the container. It has the highest rigidity of any transparent plastic material in thin section, and offers dimensional stability and toughness in temperature extremes of —40° F. to 180° F. The container offers convenience

in the home. The consumer can cook in them, serve in them, and throw them away with no dishes or pans to wash. Ekco-Alcoa's address is 1900 N. River Rd., River Grove, Ill.

◆ ◆ ◆

The new Meeco-Matic Model II Recording Differential Refractometer for continuous analysis of binary-liquid streams, developed by the Du Pont Co., is available from Manufacturers Engineering & Equipment Corp., Hatboro, Pa. The instrument is designed for plant operation, and features sensitivity 10 times higher than that of present laboratory-type refractometers. The full-scale span of the instrument is adjustable from 10^{-1} to 4×10^{-4} refractive index units. The minimum detectable change in refractive index is 1% pf full scale at any span. The new Meeco-Matic Model II is useful for determining composition of two-component liquid streams. The concentration of both gases and solids in solution can be determined by the Refractometer.

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Bakeries, frozen food processors, and other food and confection packers now can produce aluminum foil "Patti-Pans" on their own production lines with a **new press** introduced by Basca Mfg. Co., 2222 N. Olney St., Indianapolis, Ind. Three models of the press are available, using different width reels of aluminum foil up to 6". Interchangeable dies can be used with one model. All 3 models of the press can make 5,000 "Patti-Pans" per hour. No special operator training is necessary; the press requires attention only when loading foil reels. Round, square, oblong, or almost any shape dies can be used in the press to produce a foil pan of the shape and depth desired. Only limiting factor is the size of the foil blank.

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Marketing of a new water conditioner that eliminates and prevents scale and corrosion formations in boiler and water systems without use of chemicals is announced by Packard Water Conditioner Division, Packard Mfg. Co., 2220 W. Beaver St., Jacksonville 9, Fla. The unit prevents scale and corrosion by imparting added energy to the atoms of the water solution. Easily installed, there is no moving part, no expensive maintenance or servicing, either in the form of labor or chemicals. The Packard Water Conditioner is manufactured in sizes handling from 6.5 to 1760 gallons per minute for connection with corresponding standard iron pipe sizes ranging from ¾" to 12". Larger sizes are available. All conditioners carry a 10-year warranty.

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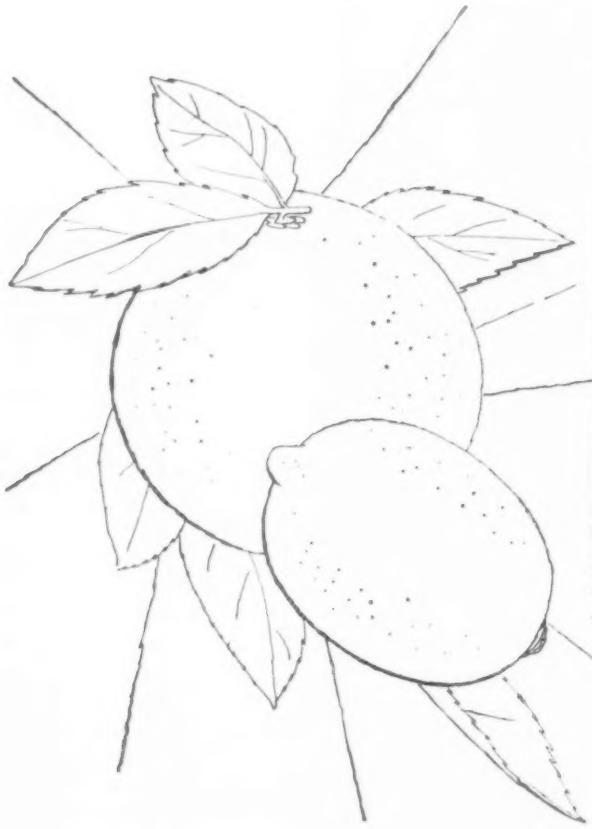
A company specializing in non-contact gauges—Industrial Gauges Corp., Englewood, N. J.—has developed a special model of their XactRAY Gauge



ACCESSORY NUTRIENT FACTORS

For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77
(Dehydrated) a Complete Culture Medium

FORMULA		
Ingredients—when rehydrated on basis of 45 grams per liter of medium.	Orange juice serum solids	12.6g*
	Agar (dry basis)	15g
	Peptone	10g
	Yeast hydrolysate	3g
	Reducing sugars, total	8g
	Sucrose, total	6g
	Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit, pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

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for these 8 reasons!

- NATURAL YELLOW COLOR Barnett's Carotene, extracted from carrots by a patented process, provides a natural hue (more yellow and less red).
- EXTRA VITAMIN POTENCY Biological assays show that Barnett's Carotene has more vitamin A potency than we claim.
- GREATER SOLUBILITY An important factor in uniform distribution of color and time-saving processing.
- STABILITY Barnett's Carotene does not affect the storage quality of food, nor impair its flavor or odor.
- WIDE COMMERCIAL ACCEPTANCE Used by many leading food processors (margarine, shortening, bakery and dairy products).
- DIFFERENT FORMS Offered as Carotene Crystals and as Carotene in Oil of various potencies. Microcrystalline Carotene in Oil (particularly adapted for use in margarine and shortening) is covered by U.S. Patent #2,477,928.
- COMPETITIVELY PRICED Increased production and improved extraction processes made recent price reductions possible . . . the lowest ever offered on high quality natural carotene.
- PACKAGED TO ORDER Barnett's Carotene will be conveniently packaged to suit your needs.

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BL

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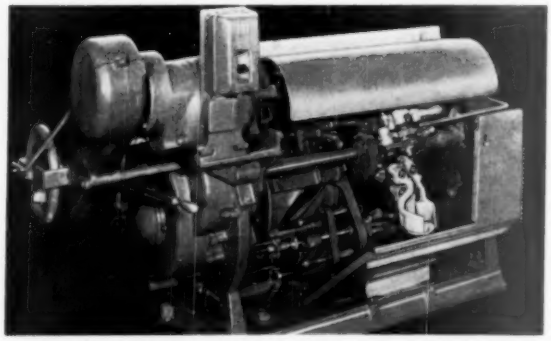
which monitors food production operations involving rolling, coating, extrusion, or classification to determine variations from pre-determined standards within 1%. The gauges, which employ X-ray beams, can give visual meter reading or can directly control and correct the processing machine. Gauges can be calibrated in any units of density or thickness desired. Permanent strip charts of material in process can be recorded.

◆ ◆ ◆

Water now can be had "faucet fresh" and fast with the new low-cost portable Crystalab DEEMAJET Model DJ-128 ion exchange water de-ion-izer.

Non-mechanical and pressure operated, the unit connects to any faucet and produces at a flow rate as great as 2 gallons per minute. Crystalab DEEMINITE CD-11 resins are the filtering medium, and change color to indicate exhaustion. Resins are replaced easily. DEEMAJET Model DJ-128 has grain removal capacity of approximately 1750 grains as NaCl, and retails for $39.50 complete. A smaller model, DEEMAJET Model DJ-64, with a grain removal capacity of approximately 900 grains as NaCl and a flow rate of one gallon per minute, retails for $25.00 complete. Manufactured by Crystal Research Laboratories, Inc., 29 Allyn St., Hartford 4, Conn.

◆ ◆ ◆

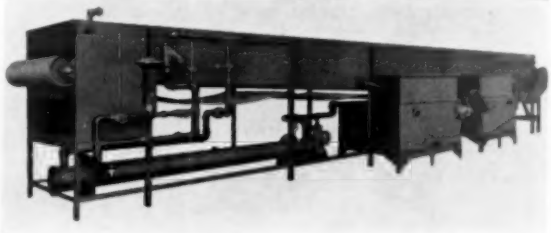


Increased product yield, greater machine capacity, and better quality are the principal characteristics of an improved model of the FMC Pear Preparation machine. Major modifications made within the last 2 years include a cup feed mechanism, a straight butt cut knife, and an expandable coring knife that provides a revolutionary technique in the preparation of the fruit.

◆ ◆ ◆

A new line of vacuum pouches, made from a specially treated film which provides extremely high resistance to the transfer of gas, air, and moisture, is offered by CRYOVAC Company Division of W. R. Grace & Co., Cambridge 40, Mass. Designed to meet the need for air-tight, moisture-proof packaging for sliced food products sold in consumer-sized units, CRYOVAC pouches will be available in a wide range of sizes. The new pouches are reported to have all the advantages of laminated pouches with none of the disadvantages. A complete selection of CRYOVAC vacuum-pouch processing equipment, priced well within the means of the small packer or supermarket, is under development, and the first of these machines is already available.

◆ ◆ ◆



Increased product yield—up to 4 cases per ton—and low operating costs realized through substantial savings in lye solution, highlight the advantages of the FMC Cup-Down Clingstone Peach Peeler. The machine is designed to peel halved peaches without subjecting the cut side or pit cavity of the fruit to the lye solution—providing considerable increases in yield. Offered in 4 standard sizes, producing from 25 to 60 tons of product per hour, the unit also is readily adaptable for peeling apricots. Additional information on either the Peach Peeler or the Pear Preparation Machine may be obtained by writing Food Machinery and Chemical Corp., Canning Machinery Division, P. O. Box 1120, San Jose 8, Calif., or 103 E. Maple St., Hoopeston, Ill.

◆ ◆ ◆

Cheslam Corp., Yonkers, N. Y., has introduced a **patented single service liquid package** that opens unlimited possibilities for the dairy industry. Key to the new packaging development is the "Controlled Flow or S-Spout" pouch which functions as a channel sealed into the top of the plastic pouch. The spout makes it possible to measure amount of cream wanted,

but prevents wasteful spilling and dripping, and retains the unused contents for future use, even when the package is laid on its side. The package itself is made from a special Cellothene, an extrusion lamination of polyethylene and cellophane made by Cheslam Corp. The clear transparency of this film has added features in that it is odorless, tasteless, non-toxic, and resistant to tear, puncture, grease, and light. It is chemically inert, flexible at low temperatures, handles easily, and is generally not affected by age. Special liquid packaging equipment, available from several manufacturers, form pouches, measure, fill, seal, and deliver in units from ¼-ounce to 3 ounces and over. For details, write the company c/o Lloyd S. Howard Associates, 420 Madison Ave., New York 17, N. Y.

. . . the literary corner

A new line of industrial fans designed to handle corrosive and explosive fumes, high temperature and humidity, abrasive dusts, and dirt-laden air is featured in a bulletin compiled by Propellair Division of Robbins & Myers, Inc., Springfield, O. Complete information on construction features, accessories, bearing assemblies, and performance of the 5 fan sizes, ranging from 16" to 36", is included. The fans are available in 2 types—for applications at normal or high temperatures—and have air delivery ratings to 26,000 cubic feet a minute.

◆ ◆ ◆

The April 15 issue of *Information Bulletin*, published by The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo., quotes Dr. Rudolph Plank, German scientist and editor of the journal *Kältetechnik* as follows: "If one is accustomed to European conditions, it is difficult to imagine the degree of significance which refrigeration technology, including air conditioning, has achieved in the United States. The high standard of living there could never have been achieved without refrigeration technology." Comments *Information Bulletin:* "In the midst of speculations that it might be desirable or useful to search for ways to circumvent refrigeration, it is well to ponder this conclusion, reached by one who is thoroughly acquainted with refrigeration science and technology on both sides of the Atlantic Ocean. It might be better to center more attention on assistance to refrigeration rather than opposition to it."

◆ ◆ ◆

Three new, exclusive features in spiral and heavy duty blenders are described in a free, file size catalog issued by American Welded Tank & Machinery Corp., 200 Liberty Ave., Mineola, L. I., N. Y. Eighteen sizes ranging from 5 cubic foot to 515 cubic foot capacity blenders for mixing and blending pastes, powders, and liquids are offered. Spiral ribbons and shafts are removable without removing washers or end assembly.

◆ ◆ ◆

Engineers and technical purchasing specialists looking for the unusual and complex in alloy sheet metal fabrication will find a helpful source of information in a new, free, 32-page purchasing guide published by S. Blickman, Inc., Weehawken, N. J. It describes how special fabrication skills solved problems involving intricate shapes, close tolerances, special welding techniques, high finishes, and mechanical components. Alloys include stainless steel, aluminum, monel, inconel, nickel, titanium, multimet alloy, hastelloy, and other metals in gauges up to ¾". Sizes vary from small assemblies to dimensions of 30' long or more.

◆ ◆ ◆

Two new patented processes for the production of synthetic glycerine are described in *Glycerine Facts*, April 15 issue, published by Glycerine Information Service, Suite 1008, 295 Madison Ave., New York 17, N. Y. In the Allied Chemical and Dye Corporation process, glycerine is obtained from allyl alcohol. The Shell Development Company technique utilizes an aqueous solution of acrolein, with osmium tetroxide as catalyst.

◆ ◆ ◆

Centralized lubrication systems installed on automatic meat packing and processing equipment provide such advantages as elimination of downtime for manual lubrication and repair, reduction of parts breakage, elimination of product spoilage due to oil drips, and precision lubrication of inaccessible bearings, according to a reprint which discusses Bijur automatic lubrication systems. For copies, write to

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◆ ◆ ◆

An improved line of A-S-H Hydroseal pumps for hydraulic ash handling systems is described in Data Sheet Pa. published by The Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa. The 12-page data sheet illustrates the design, construction, and operation of these abrasion-resistant centrifugal pumps. A cut-away view illustrates how the Hydroseal principle—a constant stream of clear water passing between moving parts—protects running clearances against wear and abrasion.

◆ ◆ ◆

The 10th edition of *Industrial Research Laboratories of the United States*, compiled by James F. Mauk, 560 pages, has been published by National Academy of Sciences—National Research Council, Washington, D. C.

◆ ◆ ◆

A new technical data sheet illustrating, describing, and giving size and capacity data for a variety of cans for packaging, storing, or shipping dry, semi-liquid, and liquid products has been issued by George D. Ellis & Sons, Inc., American and Luzerne Sts., Philadelphia 40, Pa. Write for technical data sheet No. 102.

◆ ◆ ◆

A bulletin on the new Blaw-Knox Instantizer, designed to process spray-dried powder into a form which will disperse readily in water, is available from Dairy Equipment Division, Blaw-Knox Co., Mora, Minn.

. . . *meeting hall and conference room*

"Science and the Health of Mankind" was the theme of a conference held at the M. I. T. Alumni Day observance on June 11. The occasion, dwelling on the part the scientist and engineer are playing in prolonging man's life and improving his lot, was under the chairmanship of Dr. Egon E. Kattwinkel, chief of Cardiology, Newton-Wellesley Hospital. Formal addresses were made by Dr. H. van Zile Hyde, U. S. Public Health Service; Prof. Gordon M. Fair, Harvard University; Prof. Francis O. Schmitt, M. I. T.; Prof. John G. Trump, M. I. T.; and Dr. J. George Harrar, The Rockefeller Foundation.

◆ ◆ ◆

The oldest active livestock farmers, buyers, salesmen, and others (in terms of years of service) were honored at an awards banquet in the Saddle and Sirloin Club at the Chicago Stock Yards on June 14 in connection with the market's 90th anniversary celebration. The affair was sponsored by the Stock Yards Club of Chicago, which represents a complete cross-section of the market—commission firms, livestock buyers, banks, packers, and the Chicago Union Stock Yards.

. . . *building up and branching out*

Spinco Division of Beckman Instruments, Inc., has established a Spinco service center in Munich, Germany, within the facilities of Beckman Instruments, G.m.b.H., Beckman's wholly owned subsidiary. This will enable Spinco to provide direct service to customers in Western Europe. Spinco supplies universities and laboratories with high-speed ultracentrifuges and electrophoresis equipment.

◆ ◆ ◆

The new 30,200 sq. ft. warehouse, office, and distribution center of A. E. Staley Mfg. Co., recently opened at 4616 W. Augusta Blvd., Chicago, employs bulk loading and unloading of the firm's four kinds of syrup: "Sweetose," "Sweetose" C, Intermediate Conversion, and Regular Corn Syrup Unmixed. Center photo shows a number of the company's large fleet of tank cars on the 2 switch tracks alongside the warehouse, ready to unload into the 4 huge storage tanks of nearly 100,000 gallon combined capacity within. By manual controls at a switchboard, the company's trucks are bulk loaded on the opposite side of the building (bottom photo). The warehouse also is used for storage and distribution of industrial and food starches, soy flours, monosodium glutamate, lecithin, corn and soybean oils, "Sta-Flo" Liquid Starch, and "Sta-Puf" Laundry Rinse. Headquartered at the new location are Mr. Ralph R. Dombroski, Chicago area manager, and Mr. Ross Alverson, office manager. The grocery products department of the company, of which Mr. Robert T. Murray is manager, also operates from the Chicago distribution center.

◆ ◆ ◆

Philip Olender & Co., 1951 E. Ferry, Detroit, Mich., has acquired the entire assets of Zukin Food Processors, Inc., Detroit. A complete line of fountain supplies will be available, as well as many other items

for the confectionery, ice cream, grocery, baking, and allied trades.

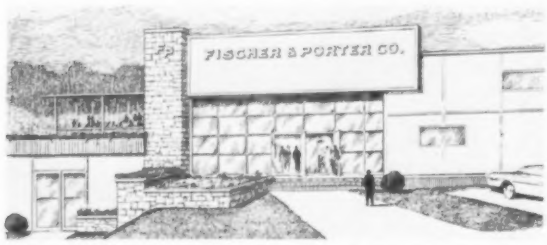
◆ ◆ ◆

Elgin Mfg. Co., manufacturer of filling and capping machines, has added Globe wrapping machines to its line. Acquiring all manufacturing rights to Globe-Wrap, all present models and their developments in the future will be known as Elgin-Wrap automatic and semi-automatic adjustable underfolding, overwrapping, and heat-sealing machines. The Elgin-Wrap is particularly valuable for economical wrapping of any rectangular or square product or carton. Elgin plans worldwide distribution of this high quality, low-cost wrapping machine line through its present sales representatives.

◆ ◆ ◆

Plans for construction of a new $250,000 manufacturing plant, office building, and laboratory at Charlotte, N. C., were announced by Stein, Hall & Co., Inc. The new facilities are designed to meet growing demand for the firm's textile and adhesive products in the South, and will replace the company's present Charlotte operation, located at 1620-22 W. Morehead St. Construction is expected to be completed by the end of 1956.

◆ ◆ ◆



Ground-breaking ceremonies for Fischer & Porter's new million-dollar office building were held on May 1 in Hatboro, Pa. The 2-story building will have over 91,000 sq. ft. of space, and will be completely air-conditioned. In addition to regular office space, a new cafeteria will be constructed on a split level between the new building and the present manufacturing plant. The cafeteria will lead to a terrace on the roof of the present plant, which will be used for outdoor dining during the summer months.

The firm also announces the completion of its divisional decentralization program with the formation of an Instrument Division, to be headed by Mr. Donald J. Tricebock, formerly assistant to the sales manager. The company now is divided into 5 product divisions—Flowmeter, Instrument, Chlorinator & Municipal, Glass, and Data Reduction & Automation.

◆ ◆ ◆

At a special meeting of stockholders of Consolidated Foods Corp., Chicago, approval was voted of the terms of Consolidated's announced acquisition of Piggly Wiggly Midwest Co., Inc., representing a further diversification in the growth pattern of Consolidated Foods. Stockholders of Piggly Wiggly previously had voted approval. Mr. Benjamin P. Kramlich, president of Piggly Wiggly Midwest Co., Inc., was elected to the board of directors of Consolidated Foods.

◆ ◆ ◆

Hunt Foods, Inc., Fullerton, Calif., has become a subsidiary of Ohio Match Co., Wadsworth, O. The enlarged organization is expected to provide expanded market and distribution potentials, and operating efficiencies are expected to result from the integration of the two managements.

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. . . *the human element*

Mutschler . . . a young man who goes East!

Mr. W. H. ("Bill") Morgan, general manager of the Cannery Equipment Service Department of Continental Can Co., has elected to avail himself of early retirement after 44 years with the firm. His position has been filled by **Mr. W. J. ("Bill") Mutschler,** formerly assistant to the general manager of Continental's Metal Division Research and Development Department in Chicago. IFT member Mutschler will make his headquarters in the New York offices of the company.

◆ ◆ ◆

From the Grocery Manufacturers of America, Inc., 205 E. 42nd St., New York 17, N. Y., comes news of the following election results. On the GMA Midwest Merchandising Committee, **Mr. Walter F. Straub,** president of W. F. Straub & Co., has been elected chairman; **Mr. Jack A. Kirkman, Jr.,** vice president in charge of sales and advertising for Red Star Yeast & Products Co., was elected vice chairman; and **Mr. Peter S. Bezek,** president of Help, Inc., continues as secretary. On the GMA Midwest Employee Relations

Committee, **Mr. Kenneth W. Rowe,** assistant to the president of Morton Salt Co., has been re-elected chairman; **Mr. Geo. B. Cox,** vice president in charge of industrial relations for The Curtiss Candy Co., was re-elected secretary.

◆ ◆ ◆

After an interval of 7 years, **Mr. Xavier Givaudan,** now in his 90th year, visited his American associate accompanied by his son **Andre.** Mr. Givaudan is chairman of the board of The Givaudan Corporation and its associate companies, Givaudan-Delawanna, Inc., Givaudan Flavors, Inc., and Sindar Corp., and is active in the management of the worldwide Givaudan organization.

◆ ◆ ◆

Polak & Schwarz, Inc., announces appointment of **Mr. Chas. H. Grimm** as manager of the New York laboratories for flavor and essential oil research. IFT member Grimm, with Polak & Schwarz for the past 2½ years, has been associated with the industry for over 20 years in various technical executive positions.

◆ ◆ ◆

Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y., announces appointment of **Mr. Harold E. Bush,** well-known candy industry executive, as manager, candy industry sales. He formerly was district sales manager, Anheuser-Busch, Inc., Corn Products Division, and general sales manager, Reymer & Bros., Inc., confectionery manufacturers.

◆ ◆ ◆

Hollenbeck . . . from Merck to Manitowoc

Dr. C. M. Hollenbeck recently was appointed director of research for Wisconsin Malting Co. The firm is building a new research laboratory at its plant in Manitowoc, Wis. IFT member Hollenbeck formerly was a group leader in the Product Development Department of the Merck & Company, Inc. Chemical Division.

◆ ◆ ◆

Four major appointments in the engineering section of the Silicone Products Department of General Electric Co., Waterford, N. Y., mark a realignment of the department's engineering effort in keeping up with the recent advances in silicone technology and the rapidly increasing demands for silicone products of all kinds. The appointments are: **Dr. Frederick M. Lewis,** manager, advance development; **Dr. Abbott Pozefsky,** manager, analytical and control methods unit; **Dr. Stuart D. Brewer,** manager, resin product engineering; and **Dr. Wm. F. Gilliam,** specialist, technical information exchange.

◆ ◆ ◆

Dr. Cyril L. Comar, chief, Biomedical Research, Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn., has been appointed a technical collaborator of the Southern Utilization Research Branch of the Agricultural Research Service, USDA, New Orleans, La. Dr. Comar is well known for his work with high energy radiation, particularly in the medical field. He was laboratory director and research coordinator, AEC, Agricultural Research Program, University of Tennessee, Knoxville, from 1948 until recently, when he became chief of Biomedical Research. He is author of the book, "Radio Isotopes in Biology and Agriculture," published in 1955.

◆ ◆ ◆

Mr. Norton J. Stromstad, Mid-west sales representative for Sterwin Chemicals Inc., 1450 Broadway, New York 18, N. Y., has been reassigned to a newly created position in the same territory. In his new capacity, he will be a special representative on behalf of Roccal, Sterwin's sanitizing agent, calling on state, county, and municipal health departments. The action, establishing closer ties with public health agencies, was prompted by the recent action permitting use of quaternary ammonium compounds as sanitizing agents in milk plants. In addition, he will service the company's distributors in the sanitary chemical field. Mr. Stromstad will continue to make his headquarters in Minneapolis.

Stromstad . . . Sterwin's sanitizing specialist

◆ ◆ ◆

Mr. W. Roberts Wood, vice president and director of National Cylinder Gas Co., Chicago, has been elected president of The Girdler Co., Louisville, Ky., a division of National Cylinder Gas. Mr. Wood succeeds **Mr. Geo. O. Boomer,** who will continue as chairman of the executive committee of the parent company. The Girdler Company designs and builds processing plants and equipment for major companies in the chemical, petroleum, food, and related fields.

◆ ◆ ◆

Dr. John J. Birdsall, food technologist, has joined the laboratory staff of the Wisconsin Alumni Research Foundation, Madison, Wis. He will specialize in flavor evaluation.

◆ ◆ ◆

Mr. Edward K. Walsh, formerly assistant general manager of sales, has been appointed general manager in charge of American Can Company's sales department. He has been with the firm since 1929.

◆ ◆ ◆

Appointment of **Mr. Geo. E. Foote** as director of sales has been announced by Chicago Stainless Equipment Corp., Chicago 30, Ill. The firm manufactures Roswell Hi-Heet Units for the elevated temperature processing of high viscosity liquids and liquid foods, as well as tanks and related standard and special stainless steel equipment.

◆ ◆ ◆

Mr. Robert J. Pierson, Jr., is the new national advertising and sales promotion manager of the Container and Plumbing and Heating Division of Rheem

Mfg. Co., 7600 S. Kedzie Ave., Chicago 29, Ill. He replaces Mr. B. Edward Soby who has resigned to start his own business in the San Francisco area in September.

◆ ◆ ◆

Election of **Mr. Karl Anderson** as a vice president of Monarch Finer Foods, a division of Consolidated Foods Corp., Chicago, was announced by Mr. V. R. Van Natta, Monarch president. In his new capacity, Mr. Anderson will continue to have charge of the firm's Houston branch.

RECENTLY ELECTED MEMBERS OF IFT

(Continued from page 30 preceding technical papers)

Mary Ann Henckler
Union Electric Co.
315 N. 12th Blvd.
St. Louis 1, Mo.

Alyce H. Holmes
Ass't Prof. Home Econ.
Virginia Polytechnic Inst.
Blacksburg, Va.

R. Bruce Holmgren
2028 Ewing Avenue
Evanston, Ill.

John G. Kennedy
410½ S. Jefferson
Mason, Mich.

Jerome Kern
8215-14th Avenue
Hyattsville, Md.

Jack Lalo
1863 Laloma Ave.
Berkeley 9, Calif.

Bernhard Larsen
Supplee-Wills-Jones Milk Co.
15 S. 34th Street
Philadelphia 4, Pa.

W. R. Lenderking
Lily-Tulip Cup Corp.
2 Pine St., Room 606
San Francisco 11, Calif.

Eulalia H. Lim
168 Vito Cruz
Manila, Philippines

Fernand Mailloux
The Mount Royal Industries, Inc.
7550 St. Dominique St.
Montreal 14, Que., Canada

M. C. Midgley
4010 Everett Avenue
Oakland 2, Calif.

Ralph E. Mitchell
W. J. Bush & Co. (Canada) Ltd.
312 St. Patrick St.
Ville LaSalle, P. Q., Canada

Charles E. Neal
Univ. of Wisconsin
Dept. of Dairy & Food Ind.
Madison, Wis.

Edward W. Page
9 Hancock Road
Hingham, Mass.

Alfred R. Prater
CSIRO Private Bag
Homebush, N.S.W.,
Australia

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1 W. 68th St. Apt. 1-A
New York 23, N. Y.

Conrado Resurreccion
818 Josefina St., Sampaloc
Manila, Philippines

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3517 Gratiot St.
St. Louis 3, Mo.

Milton E. Ryberg
165 Arlo Road
Staten Island 1, N. Y.

Charles R. Scott
The Dow Chemical Co.
Biochemical Research Dept.
Midland, Mich.

Ernest L. Semersky
Bunte-Chase Candy Co.
3301 W. Franklin Blvd.
Chicago 24, Ill.

James T. Simons
314 S. Austin Blvd.
Oak Park, Ill.

E. Ray Spence
118 Mason St.
Mason, Mich.

Donald H. Stanbridge
1978 St. Francis Way
San Carlos, Calif.

William E. Stone
Apt. Postal 28966
Mexico 17, D.F., Mexico

G. E. Teuton
Stokely-Van Camp Inc.
941 N. Meridian St.
Indianapolis, Ind.

Francis Tripp
New Bedford Inst. of Tex. & Tech.
1191 Purchase St.
New Bedford, Mass.

Warren E. Weigand
70-30 66 Place
Glendale 27, N. Y.

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Dr. Lloyd D. Witter
University of Illinois
Dept. of Food Technology
Urbana, Ill.

Charles W. York
The Canner Publ. Co.
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Chicago 3, Ill.

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Martin M. Lilie
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Jerome Messinger
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Paul Okamoto
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Ronald K. Tuttle
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Melvin Waters
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Robert K. Wegge
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EMPLOYMENT NOTICES

EXECUTIVE SECRETARY

Opportunity for an experienced Executive-Technologist to participate in the exciting new field of Radiation Preservation of Foods. Experience is desirable in such fields as committee work and programming. Demonstrated capacity for dealing efficiently with top-flight governmental and industrial representatives is essential. Must have ability to work under pressure and to skillfully handle administrative problems. Technical background in food field highly desirable. Washington area. REPLY BOX 483, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

United Nations World Health Organization invites applications for the post of Food Analyst for recently established public health laboratory in Teheran, Iran, to conduct chemical analyses of foods for regulatory purposes, to determine the nutritional value of foods and to undertake vitamin assays. The incumbent will be responsible for management of laboratory and training of national staff and laboratory assistants. A BSc. in Chemistry or a related science from a recognized university required, with at least five years' experience in food analysis. Two-year contract: basis salary from U. S. $6,000-7,300 p.a., depending on qualifications; plus certain allowances and travel costs. Applicants are requested to write to Chief, Personnel Section, World Health Organization, Geneva, for further information quoting "Iran 7.630". Closing date for applications—August 31.

NATIONAL VEGETABLE PROCESSOR, renowned for quality, seeks biochemist with advanced degree to develop Agricultural Chemicals Program and work on variety of projects with Process Research Manager. Midwest location. Submit complete résumé. REPLY BOX 474, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

Grocery chain wants experienced Food Technologist to head up established Products Control Department offering technical service to Buying, Merchandising, and Production Departments. The man sought is approximately 30 years old and presently holding a responsible position. College degree and several years experience in bakery, flour mill, canning, dairy, or other branch of food handling required. He should have a firm foundation of laboratory experience and a broad inquiring approach to those phases of the operation which may open up to him. Northeastern location. Send full resumé, salary requirements, and photograph (if available) with first letter. Replies confidential. REPLY BOX 480, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

POSITION WANTED: FOOD TECHNOLOGIST - CHEMICAL ENGINEER. Extensive varied experience Canning, Quality Control, Sauce Formulations, Kraut Fermentation and Specialty Products. Knowledge of Dairy, Cheese and Ice Cream Products. Capable of initiating efficient Quality Control and Cost Control Systems. REPLY BOX 482, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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AVAILABLE: Technical Salesman, 35 yrs. old, graduate chemist. Eight years with flavor and essential oil firm plus administrative and market research background. Presently in Chicago, will relocate. Seeking position in sales or product development with similar or related line. REPLY BOX 484, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Laboratory Manager—Experienced in establishing, developing and organizing quality control, analytical, and research laboratories. Academic background in management, chemistry and botanical science. Laboratories under my direction have been and are to date self-supporting and profit making. Salary expected approximately $10,000 per year with cost of living adjustment for location plus bonus. REPLY BOX 481, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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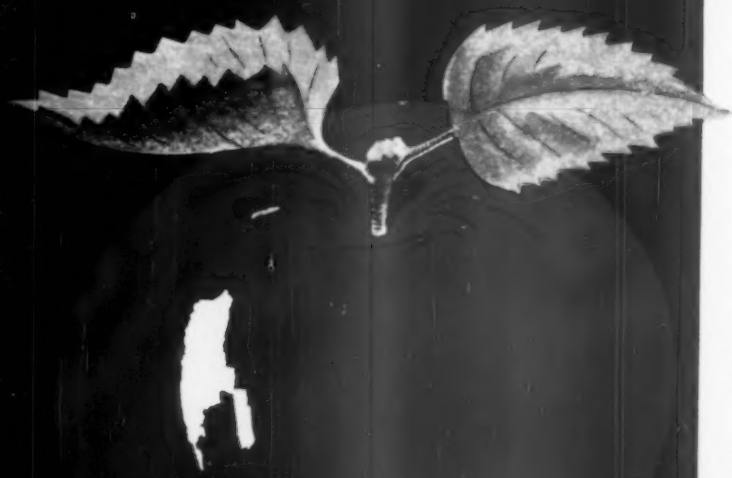

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